Volume 27 DECEMBER, 1920 Number 4

MACHINERY

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The Editor's Monthly Talk

MACHINERY'S specially conducted tour to the industrial centers and machine shops of the country is full of interest this month, the journey through the reading pages including visits to thirty-two different plants in thirty-two different cities and towns in the United States. The guides are the thirty-one authors of the seventy-four pages of shop and engineering articles in this number of MACHINERY—exclusive of the department of New Machinery and Tools, which covers all the developments of the month in the machine-tool building and accessories field.

Among the plants visited are some very well known throughout the world—The General Electric Co.'s plants at Schenectady, N. Y., and Lynn, Mass.; The Norton Co., Worcester, Mass.; The Putnam Machine Works plant at Fitchburg, Mass., of Manning, Maxwell & Moore, Inc.; The Clark Equipment Co., Buchanan, Mich.; The De Laval Separator Co., Poughkeepsie, N. Y.; and the Mueller Metals Co., Port Huron, Mich. The reader may sit in his easy chair at home and visit all these leading plants, because the editors of MACHINERY have done the traveling for him; in seeking and verifying the information published in this one number they covered over 5000 miles, visited dozens of shops in addition to those mentioned, and gathered information from scores of executives and engineers.

This is the method—and the only method—by which MACHINERY can keep its readers accurately posted on the latest developments and practices in the metal working field, giving the information required by practical men on shop practice, machine design, shop and drafting-room systems, engineering developments, and training methods. In addition, MACHINERY must review the conditions in the domestic and foreign machine tool trade; the latter subject, in this number, is dealt with in articles by special correspondents writing from England, Germany, and Spain. So much for this number.

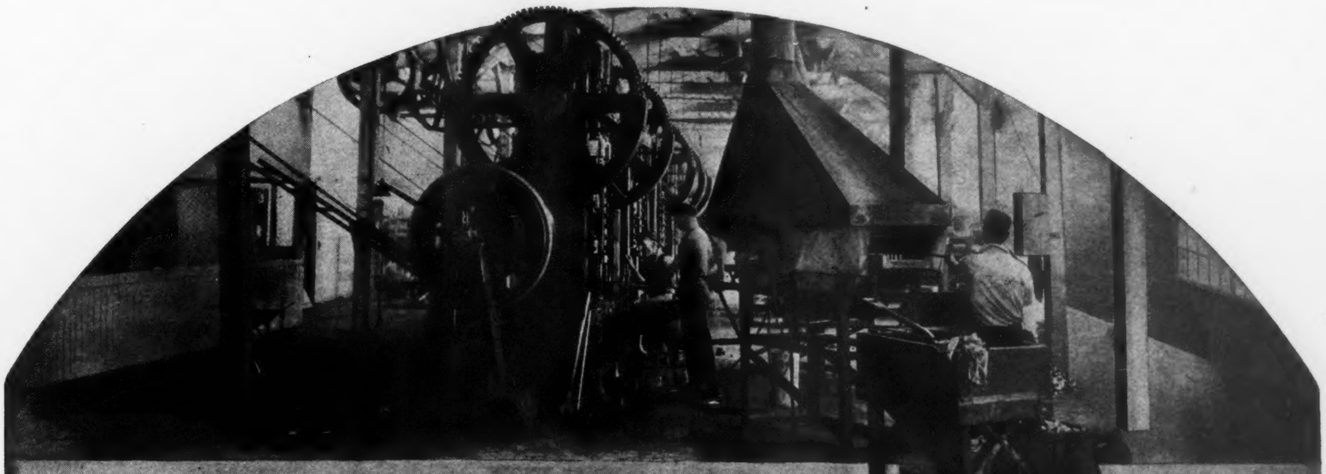
In January MACHINERY a new and important series on shop practice begins. MACHINERY has published complete treatises on Modern Grinding Practice; Gage Design and Gage-making; Drilling Practice; Thread-cutting Methods; Electric and Oxy-acetylene Welding; Automatic Screw Machines; Production Milling; Tools, Chucks, and Fixtures; and Turret Lathe Practice. The new series will cover another large and important sub-division of machine shop work—Production Planing and Shaper and Slotter Work, presenting the most advanced practice to be found in American machine shops. In the preparation of these articles, dozens of shops were visited, and the completed treatise represents the combined experience of both manufacturers and users of planers. This series adds another link to the chain of shop practice articles which, when finished, will present a complete set of treatises on the operation of modern machine tools in progressive American shops.

The hard and trying experience of the past four years has brought home to manufacturers with great force the vital importance of a better training of men for the mechanical industries. The importance of good methods of training inexperienced help —thoroughly as well as rapidly—is recognized by everyone. The problem has been solved with satisfactory results by the Norton Co., Worcester, Mass. In "Training Operators in a Machine Shop," John C. Spence, superintendent of the grinding machine division, describes in detail the methods used, reviews the results, and gives details in regard to the cost of such a training department—information which is of definite value to any manufacturer contemplating the organization of a training department. With the old type of apprenticeship system in existence only in a few plants, the effective method described ensures successful training of good operators and makes it possible to obtain skilled machinists without depending upon the limited supply available through apprenticeships. Mr. Spence's plan has much to commend it even when compared with the regular apprenticeship systems, and has proved its advantages over these systems in many ways.

It goes without saying that the work of the designing room and the drawing office—where the plans are made—is of equal importance to that of the shop—where the plans are executed. This brings us to a brief notice of an unusual series to begin in January MACHINERY: "Causes of Common Errors in Machine Design," by R. H. McMinn. The author has made a careful study of drafting and designing room errors and their underlying causes, and shows how to avoid them. The information he gives will not be found in any of the hitherto published literature on the subject of machine design and of manufacturing practice as affected by the design. The subject of errors in machine design is dealt with from many different viewpoints, on the assumption that anything adversely affecting operating results, manufacturing costs, the quality of the product, or the reputation of the manufacturer, is an error in designing, if it can be traced back to the work of the drafting room.

The subjects mentioned are only some of the more important to appear in January. Besides these, there will be articles dealing with some out-of-the-ordinary drawing operations on the power press; tractor engine shop practice; the use of sand-blasting apparatus; and an analytical and unusual treatise dealing with the work-speed in cylindrical grinding. No number of MACHINERY fails to show some interesting phase of automobile shop practice, and January will be no exception. As usual, MACHINERY will take its readers into more than a score of leading plants in the country and will show them the advanced practice and the improved methods that result in more production and greater accuracy.

These informal notes give the Editor an opportunity to tell about the articles in preparation and bring him, perhaps, a little closer to the readers. Very often they serve to point out the relative significance of some phase of practice, some new method, principle or development, thus lighting the mechanical highway a little in advance for those who, being busy about their own affairs, must depend upon the work of an engineering journal to discover and describe for them whatever is new that is worth while.



Making Brass Forgings

Methods Developed by the Mueller Metals Co., Port Huron, Mich., in an Original and New Art of Metal Working

By EDWARD K. HAMMOND

IN Great Britain and on the European continent, many parts which are made of brass, bronze, and other non-ferrous metals are forged to the desired form in dies. The British call this process "stamping," but although the work is done under a power press, such a term would prove misleading in this country, because we regard a stamping as a part cut from sheet metal by a die. In America, either the term "forging" or "die-pressed casting" is more generally used.

During the war, brass forgings or so-called "die-pressed castings" were made in large quantities to be subsequently machined into various fuse parts, but otherwise, the forging of brass in dies has not found wide application in the United States. However, the advantages of the process are so obvious that it is doubtless only a matter of time until many parts which are now cast in sand or machined from bar stock will be produced by this method.

An article entitled "The Production of Die-pressed Castings" was published in MACHINERY, January, 1916, which explained the making of various fuse parts and suggested other applications of the method in handling certain lines of commercial work. Such a general application of the process of forging brass is now being made by the Mueller Metals Co., in Port Huron, Mich. This firm's plant is equipped for the manufacture of various products from non-ferrous metals, including copper and brass rods and seamless tubing, screw machine products, sand-molded castings, and die-castings, etc. One of the departments of the plant does contract work in the manufacture of brass, bronze, and copper forgings, and it is with the practice of this department that the present article is concerned.

Extensive and valuable experience for the development of this branch of the business was obtained in the Mueller plant in Sarina, Ont., Canada, where the production of forgings for fuse parts had attained a daily output of 225,000 at the time that the armistice was signed. An idea of the range of commercial work which has already been successfully handled by the Mueller Metals Co. in Port Huron, will be gathered by reference to Figs. 1 and 2 which show, respectively, a collection of finished parts made from forgings, and a group of finished parts together with the untrimmed forgings and the blanks from which these pieces are produced. A careful study of these illustrations will prove instructive to men who are interested in the forging of brass and similar metals, as it will show the wide range of work that can be handled. Evidently, there can be considerable complications in the form of the work, including the presence of one or more holes, and where an extremely fine finish is required, it is important to note that the forging is brought to the desired form, merely leaving a sufficient quantity of metal for machining to provide for cleaning up the surface.

Grades of brass that can be successfully forged include yellow brass mixtures of about the following composition: Copper, 58 to 62 per cent; lead, 0 to 3 per cent; tin, 0 to 2.5 per cent; and zinc, 42 to 32.5 per cent. This brass usually contains from 1.5 to 2 per cent lead to make it soft enough to machine easily, and it is preferable to keep the tin content at a minimum.

Where strength is required and there is little subsequent machining to be done on a forging, either manganese

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Several noteworthy advantages are secured by forging brass, bronze, or copper parts to the required shape, instead of turning the work from bar stock on an automatic screw machine or making it by some other familiar method of manufacture. Chief among these are the facts that it is possible to effect a substantial saving of high-priced metal; that parts can often be forged in a way that enables them to be utilized with little if any subsequent machine work, thus saving a heavy labor cost; and that the process of forging imparts greater density, freedom from porosity, and additional strength to the metal.

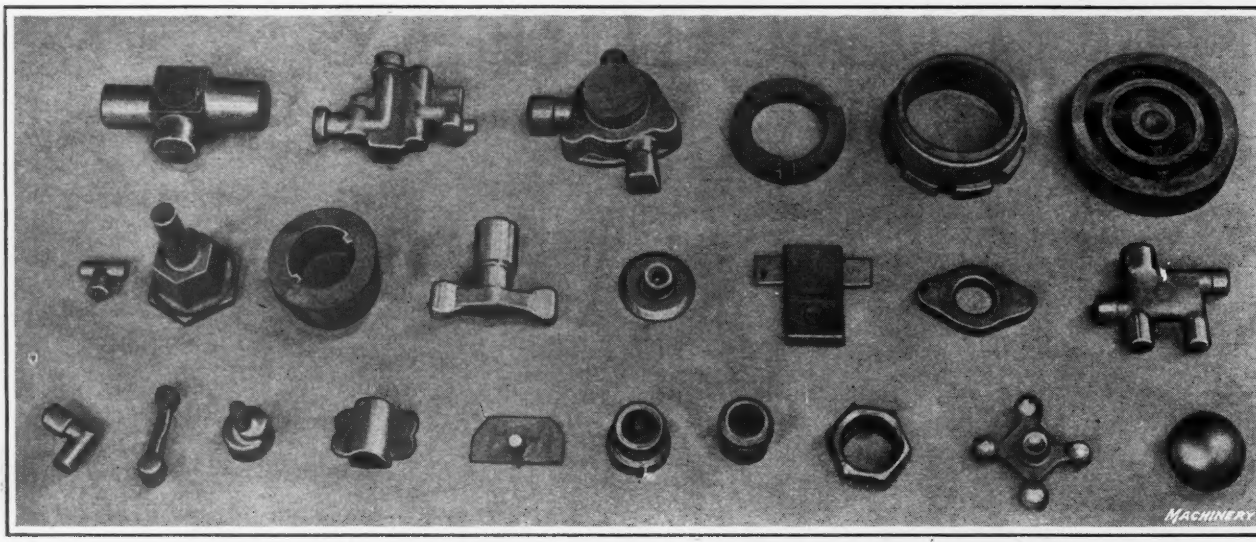


Fig. 1. Miscellaneous Collection of Forgings which gives an Idea of the Range of Work that can be produced

bronze or tobin bronze can be advantageously employed. The composition of an average manganese bronze is as follows: Aluminum, 0.5 per cent; copper, 58 per cent; iron, 1 per cent; lead, 0.2 per cent (not over); tin, 2 per cent; and zinc, 38.3 per cent. In manganese bronze, manganese is added as a deoxidizing agent, and it does not remain in the finished metal.

Tobin bronze of the kind used for making forgings has the following composition: Copper, 60 per cent; lead, none; tin, 2 per cent; and zinc, 38 per cent.

Another metal used for forgings is aluminum bronze having approximately the following composition: Aluminum, 10 per cent; and copper, 90 per cent.

Method of Procedure in Forging Brass

In making forgings of this type, the method of procedure is to squeeze a heated blank of metal between a pair of dies, which will cause the metal to flow sufficiently to completely fill the space between the upper and lower die members, which is of the same form as the forging that is to be produced. The metal blanks are usually made by cutting off pieces from extruded rods which have been sent directly to the forging shop without being submitted to the customary cold-drawing and strengthening operations after extrusion, as such work would simply add to the cost of the raw materials of the industry without giving any value in return. An article entitled "Extruding Brass and Copper Rods," published in MACHINERY for September, explained the method of making rods by the extrusion process, so that this part of the work does not require attention in the present article. It is desirable to provide for forging pieces to the desired shape without requiring the metal to flow further than is absolutely necessary; and with that idea in mind a practice is often made of extruding specially formed bars, the cross-section of which is a rough approximation of the finished form of the forgings that are to be made.

Examples of this kind are shown at *F* and *G* in Fig. 2, where it will be seen that the metal blank from which this forging is made has an outline somewhat similar to that of the finished forging. The extruded bars are sent to the forging shop, where they are set up on metal band-saw cutting-off machines, as shown in Fig. 3, each of these machines

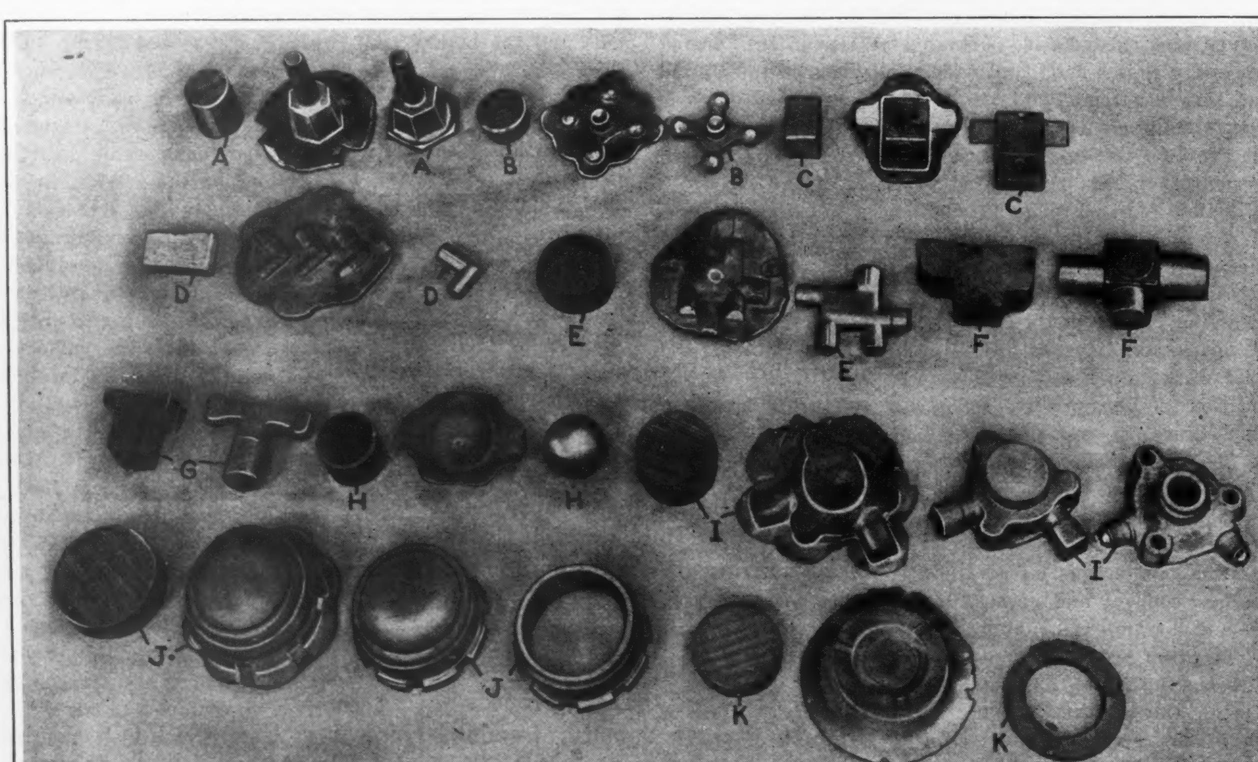


Fig. 2. Groups of Parts comprising the Metal Blank, the Forging as it leaves the Die, and the Finished Work after trimming off the Flash

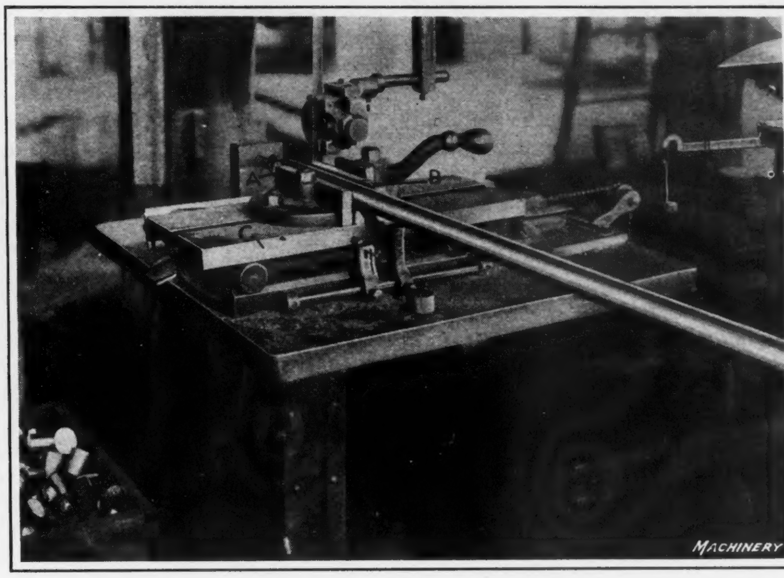


Fig. 3. Metal-cutting Band Saw equipped with End Stop, Quick-acting Vise and Traveling Table for rapidly cutting Bars into Forging Blanks

being equipped with an end stop *A* that locates the bar in the proper position to enable the saw to cut off a blank of the required length; and after the bar has been located and tightened in the quick-acting vise *B*, a longitudinal movement of the carriage *C* is utilized to provide for cutting off the blank. With an equipment of this kind, the operation can be conducted with great rapidity. If the blanks are not required to have their ends square, they can be more economically cut off in a shearing machine.

Heating the Blanks Preparatory to Forging

Oil-fired furnaces of the type shown in Fig. 4 are used to heat the blanks preparatory to forging them to shape, the practice being to raise the temperature to about 1250 to 1300 degrees F. Very accurate control of the heating is not essential, and it is the practice to judge the temperature of the work by its color, without resorting to the use of pyrometers. The furnaces in which the blanks are heated are open at both ends, and one attendant is kept constantly busy placing blanks in the front door of the furnace. It is the practice to arrange these blanks in groups, and the furnace attendant is provided with a poker *A* that has a cross-bar *B* of about the width of the furnace hearth, with which he can push forward successive groups of blanks. Formerly it was the practice to have a furnace hearth made of cast iron, but it was found that trouble was experienced through particles of iron or iron oxide becoming embedded in the work and preventing the production of perfect castings.

To overcome this objectionable feature, the furnace hearth *C* is now made of copper. Not only is it more durable, but the use of this material effectually overcomes the trouble caused by the non-ferrous forgings becoming contaminated with iron. These copper furnace hearths are capable of giving from 1200 to 1500 hours of service. The blanks are kept moving forward through the furnace, and by the time any one group has reached the farther end, the temperature has been sufficiently raised to provide for performing the forging operation. One furnace is provided for each power press in the shop, as shown in the heading illustration, and in addition to the furnace attendant, a press operator and a helper are needed. The helper's duty is to take the heated blanks out of the furnace, and place them in the die; and after the forging operation, he is also required to remove the finished forging.

Lubrication of the Forging Dies

As soon as the forging has been taken out of the die, the operator proceeds to lubricate the upper and lower dies shown in Fig. 5, with cylinder oil applied with a long-handled swab *A*. This oil is necessary to prevent the excessive pressure from causing the dies to wear with undue rapidity. The number of forgings that can be produced from a pair of dies varies according to the nature of the work, but the average will be from 15,000 to 18,000. In some cases, it is found that greater durability of the dies is accomplished by adding 1 per cent of powdered graphite to the cylinder oil to give it slightly more body to resist the pressure. Good forgings produced by this method can be held within an accuracy of $\pm$ 0.002 inch; and on average work from 6000 to 10,000 forgings can be obtained from one press in a ten-hour working day. In Fig. 5 the heated blank is shown at *B* ready to be placed in the die *C*, and a finished forging is shown at *D*.

Principles Governing Construction and Use of Forging Dies

It will be self-evident that the dies used for producing brass forgings will vary according to the nature of the work,

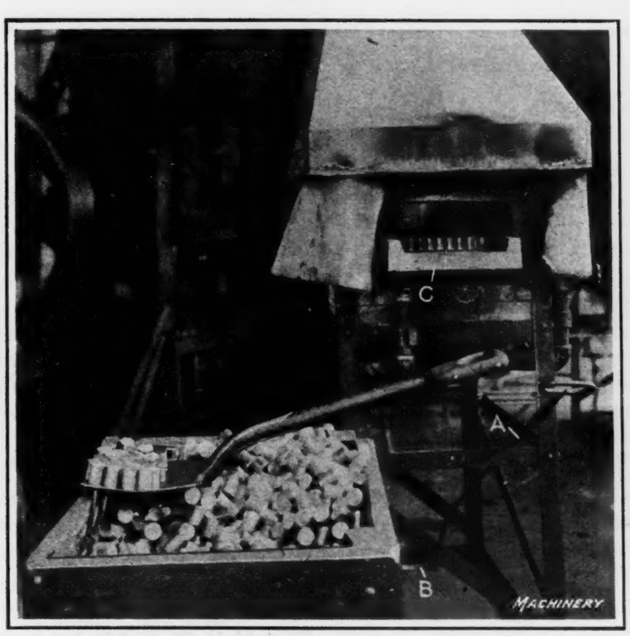


Fig. 4. Arrangement of Oil-fired Furnace in which the Blanks are heated preparatory to forging

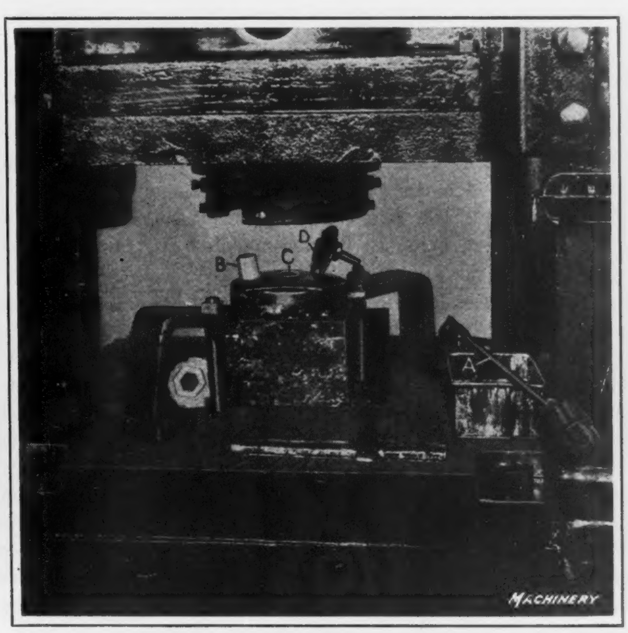


Fig. 5. Double-action Power Press equipped with Compound Dies for producing Forgings D

but there are certain fundamental principles which the experience of the Mueller Metals Co. has shown to be generally applicable in making dies. Among these, the following points may be mentioned:

Use of Double-action Press and Dies—Where the metal is required to flow through a considerable distance, it will usually be found advantageous to utilize a double-acting power press, and to have the die arranged in such a way that the first movement of the press ram results in closing the upper and lower die members to enclose the heated metal blank to be forged. Then the second stage of the ram's movement results in bringing down a plunger through the upper die member, to provide for applying pressure to the heated metal blank and causing it to flow out and completely fill the die.

Providing an Air Vent in the Dies—Where the impression in a die is of sufficient depth to cause an air pocket of considerable volume to be formed, provision must be made for allowing this air to escape; otherwise, difficulty might be experienced from the air retarding the flow of the metal to fill the die space. Several methods of accomplishing this result are employed, but the most satisfactory one is to use a No. 70 drill with which one or more holes are made, to allow the air to escape. The heated metal flows into these holes and solidifies, but the "needles" of brass so formed do not interfere with the removal of the finished forging, and when the next blank is introduced, the pressure of the metal will force the previously formed needles out of the holes, thus allowing the air to escape.

Standardization of Die Parts—Owing to the high temperatures at which the metal is forged in these dies, experience has shown it to be desirable to use a good grade of high-speed tool steel containing 18 per cent of tungsten for the die members in which the hot blank is pressed into a forging of the desired shape; but it would be too expensive to use steel of this kind to make the entire die, and so a practice is made of mounting high-speed steel inserts in holders made of carbon tool steel or of machine steel, according to the requirements of the work. The Mueller Metals Co. takes contracts from manufacturers for the production of brass forgings, and as the character of the work is constantly changing, it will be evident that there are a large number of dies to be made. With a view to simplifying both the work of designing and making these tools, the design of the dies has been standardized as far as possible. In this way it has also been found that standard die-holders can be utilized for carrying a variety of different high-speed steel inserts which must be especially formed for each particular job. This practice will be better understood by referring to the illustrations of single-action and of double-action dies shown in Figs. 6 and 8, and 7 and 9, respectively.

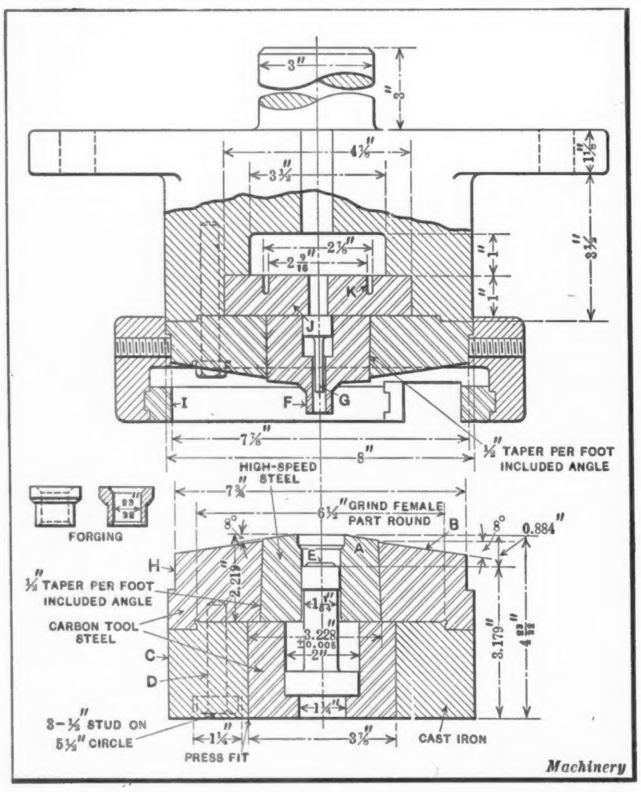


Fig. 6. Single-action Dies for forging Brass Union Seat Couplings

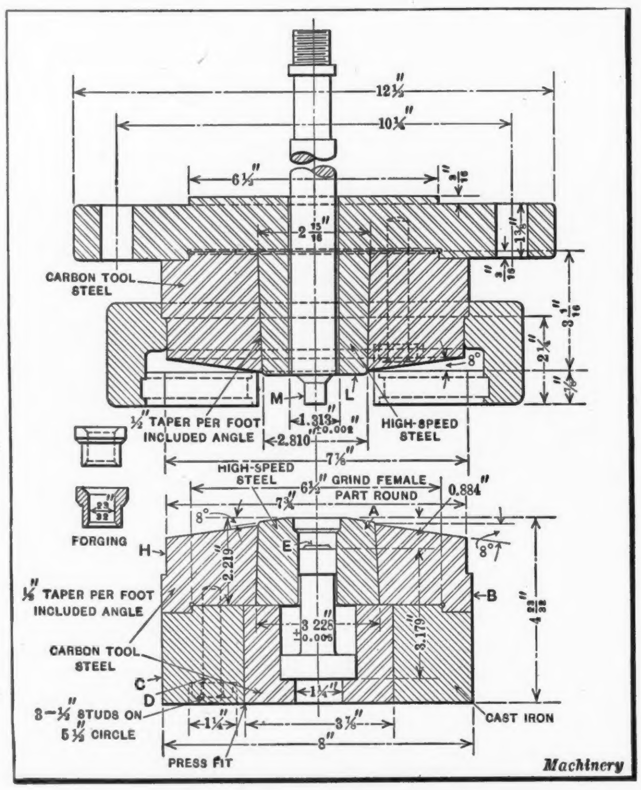


Fig. 7. Double-action Dies for forging Brass Union Seat Couplings

Description of Two Typical Forging Dies

Figs. 6 and 7 show, respectively, single-action and compound dies made for the production of brass forgings for one of the three parts of a pipe coupling, a side and cross-sectional view of one of the finished forgings being shown in each illustration. It will be noticed that in each case the lower die member is the same. Referring first to this part of the tool, it will be evident that the interior of the high-speed steel insert *A* is formed like the outside of the piece to be forged, and this insert is tapered on the outside so that it can be assembled into a carbon tool steel die-holder *B*. After insert *A* has been placed in the opening in block *B*, this block is secured to a cast-iron base *C* by means of bolts *D*. Carried in this die member, there is a stripper *E* that provides for raising the finished forging out of the die.

Bearing in mind that this forging operation is performed on a single-action press, it will be seen that the upper die member has a pilot *F* that forms the opening on the inside of the work, and there is a small stripper *G* to remove the finished forging from the pilot in case it tends to stick at this point. Between the pilot *F* and the horizontal face of the high-speed steel insert in the upper die, there is a beveled or filleted surface which provides for producing the required bevel between the top of the forging and the central hole.

Maintenance of Alignment of Upper and Lower Die Members

In making all kinds of forging dies, there are two points which require careful attention, namely, the provision for keeping the upper and lower die members in accurate alignment, and the furnishing of means in the die for protecting the crankshaft of the power press from damage in the event of the die becoming blocked. Both of these points are well taken care of in the dies shown in Figs. 6 and 7, and refer-

ring to Fig. 6 it will be seen that to keep the dies in alignment, the outside surface *H* of the lower member is machined to form a pilot that enters into the tool-steel guide ring *I* on the upper member. This guide ring *I* engages pilot *H* on the lower member before the forging operation commences, thus assuring accurate alignment of the dies and a high degree of accuracy in the finished work.

Various methods are employed for protecting the crankshaft of the press from damage, but the arrangement here illustrated has been found as satisfactory as any. It will be seen that a cast-iron block *J* has been placed above the upper die in a pocket in the holder in which this die is supported. Cut in the upper side of block *J* there is an annular groove *K*, the function of which is to so reduce the shearing strength of block *J* that in the event of the die becoming jammed, block *J* will be sheared at the annular groove *K* before the stress on the crankshaft of the press approaches the elastic limit of the steel. It will be evident that above block *J* there is a pocket that provides clearance for the disk that may be sheared out of the block, so that the crankshaft of the press will be freed of its load by allowing the tool-steel die member *F* to rise in its holder. Before such a safety device for overcoming a difficulty of this nature was developed, it was not a rare occurrence for a crankshaft to be broken and cause a serious delay before a repair could be made.

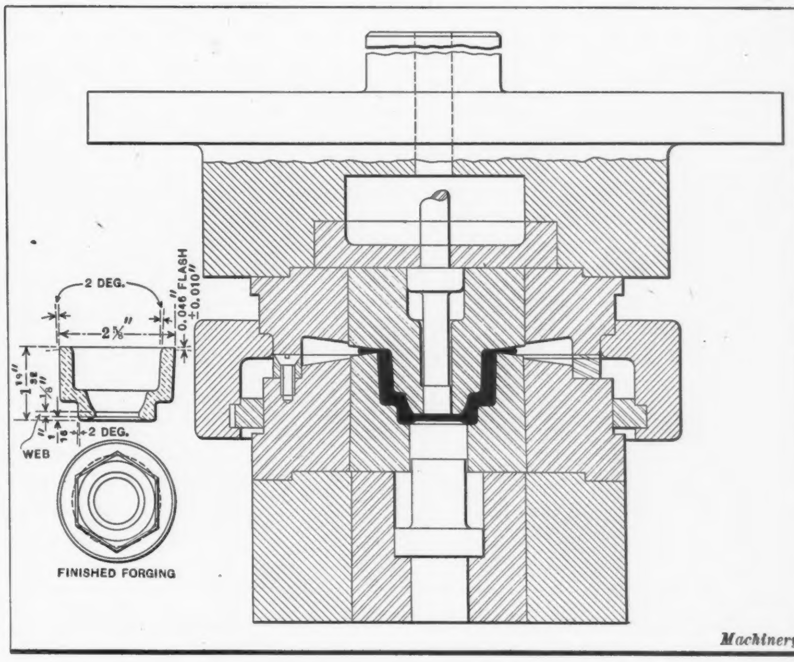


Fig. 8. Single-action Dies for forging Bronze Change-speed Lever Ball Sockets

Application of the Extrusion Principle in Forging Brass

Where forging operations are performed with compound dies and double-action presses, the process is more truly one of extrusion than of forging. Referring to the die shown in Fig. 7, it will be apparent that the lower member is of the same construction as that of the single-action die illustrated in Fig. 6, and the same provision is made for maintaining alignment of the upper and lower die members. In using a die of this type, the ram of the press makes its first downward movement and brings die member *L* down on top of the heated blank placed in the opening in the lower die, so that the metal is confined.

At the second stage of the movement of the power press ram, a plunger *M* carried by the upper die descends on the heated blank and applies sufficient pressure to cause the metal to flow and thoroughly fill the die opening. It will be apparent that an axial opening has to be forged in the work, and, as in the case of the single-action die, this is accomplished by means of a pilot on the upper die member. However, in the production of pieces of work of this kind, it is a general principle that the opening cannot be forged all of the way through the work without resorting to the use of a die, the construction of which would be too expensive in cases where only a limited number of parts are to be produced on an order.

The method of procedure followed in making a die for forgings with an opening through the middle is to depend upon the stripper to form a slight indentation in the under side of the forging and to have the pilot on the upper die produce practically the entire opening, leaving a thin web of metal, which closes the hole at the time the forging is removed from the first set of dies. By having this web of metal located slightly above the bottom of the forging, it can be sheared out without leaving a burr. In addition to this excess metal closing the opening, there will also be a flash of metal surrounding the forging at the point where the upper and lower dies come together; and two subsequent trimming operations must be performed on the work to remove the surplus metal at these two points.

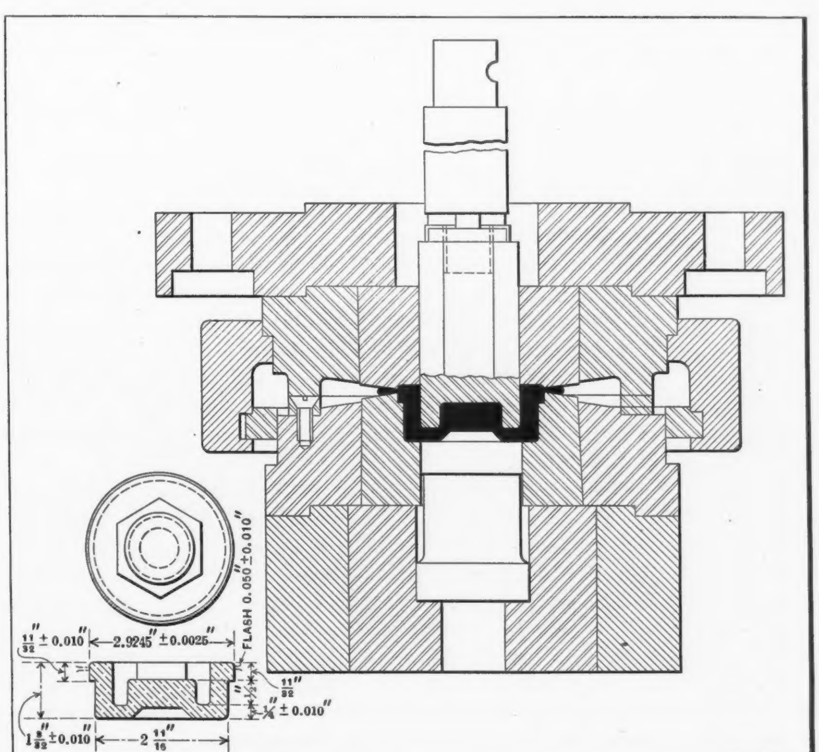


Fig. 9. Double-action Dies for forging Brass Motor Cylinder Valve Chamber Plug Inlets

Simple trimming dies are utilized for the purpose, which are set up on single-action power presses so that the pieces of work can be put in these dies without being previously heated, to first have the web of metal struck out of the central hole and then have the circumferential flash trimmed off. Fig. 10 illustrates a power press with a die for trimming forgings, one of the untrimmed pieces of work being shown at *A*, while a finished forging is shown at *B*, and the flash at *C*. After these two operations have been performed,

the forgings are sent to a pickling bath where they are first dipped in a solution of 5 per cent nitric acid and then washed in clear water, after which they are ready either for shipment or for subsequent machine work which is done on the forgings before they leave the factory.

Other Examples of Die Construction

Figs. 8 and 9 show, respectively, two other examples of single-action and double-action forging dies, and in this case the work is shown in position between the upper and lower die members. The high-speed steel inserts are the only special parts of these tools, the remaining members being of standard types, so that after the contract for these particular forgings has been completed, other die inserts may be substituted to adapt the remainder of the tools for use on other work. From the preceding description of single-action and compound dies illustrated in Figs. 6 and 7, the reader will be able to understand the general arrangement of the two present tools without requiring a detailed description. However, it may be mentioned that the dies shown in Fig. 9 are used for forging motor cylinder valve chamber plug inlets from brass; the detailed views of one of these parts in the lower left-hand corner are of interest in that they show the limits within which the diameter and the height dimensions of the work must be held. The dies illustrated in Fig. 8 are used for forging bronze change-speed lever ball sockets, and it will be apparent from the detailed views of one of these parts shown at the left-hand side of the illustration that this is another case in which it is required to produce an opening extending right through the work. However, as previously explained, the formation of this opening cannot be completed during the forging operation. It will be noticed that a web of metal 1/8 inch in thickness is left at a distance of 1/16 inch from the bottom of the forging, this impression on the under side of the work being produced by the stripper in the lower die member. The web so produced will be removed by a subsequent operation with a trimming die.

Fig. 10. Power Press equipped for trimming Forgings A to remove Flash C from Forging, as shown at B

Advantages of Non-ferrous Forgings

There are several advantageous features of aluminum, brass, bronze, and copper forgings. Important among these is the fact that owing to their greater strength, pieces made of other materials than iron and steel can be of smaller cross-sectional area when forgings are used, thus effecting an economy in the use of metal. The density of the metal is also greater, and hence there is less porosity. Consequently, brass and similar forgings can be successfully utilized in making connections and other parts for use on air lines where the high pressure might cause leakage through more porous connections. The same applies to the use of forgings in gasoline pipe lines, etc. Production costs are lower because of the saving of material, as compared with cases where similar parts are made by machining from bar stock on automatic screw machines. Also, there is a saving of labor, because the time required to do the work is far less than when all of the forming has to be done on a machine. In many cases, the finish produced by forging is found satisfactory, without any subsequent machine work.

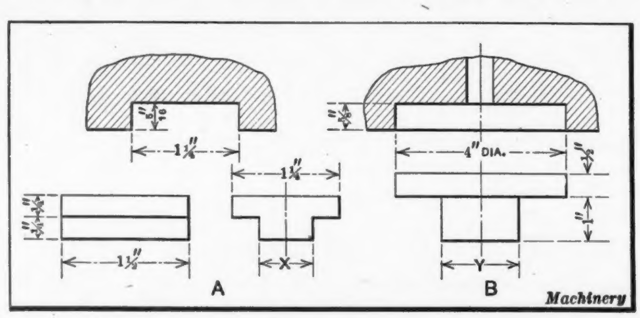
Mention has already been made of the fact that when necessary, the diameters of cylindrical forgings can be held within limits of ± 0.002 inch; but it is not feasible to attempt to hold other dimensions closer than 0.008 inch, owing to variations in the size of the blanks to be forged and the consequent spring of the press. In cutting the blanks off from bar stock, their volume is held as close as possible to the desired size by having a weighing scale provided near each of the cutting-off machines, so that at frequent intervals the operator can take a blank and weigh it to see that he is holding the weight within specified limits. The largest forgings which have been produced by this method up to the present time weigh approximately three pounds.

* * *

LOCATING KEYS AND PLUGS FOR FIXTURES

By W. OWEN

Keys and plugs of the type shown in the accompanying illustration enable milling, planing, and boring fixtures and the arbors of gear-hobbing machines, to be located on the machine tables without the heavy hammering which is frequently necessary. Such hammering nicks the slots of a table and in time causes the machine to become inaccurate. Two keys of the dimensions shown at *A* are employed for



Keys and Plugs of Standard Dimensions for locating Fixtures on Milling, Planing, Boring Machines, etc.

locating milling and planing fixtures. The dimensions given are standard for all machines, except dimension *X*, which must be made to suit the T-slot in the table of each particular machine. A slot of the size shown above the keys is milled across the base of the fixture to receive the keys, the fit between the keys and the slot being a sliding one. When the operator desires to mount a fixture on a machine table, he first places the keys in one of the table slots and then sets the fixture over them. This insures accurate location of the fixture.

A plug for locating boring fixtures and gear-hobbing arbors on the tables of the respective machines, is shown at *B*, the dimensions given being standard for all cases, except dimension *Y* which must suit the hole of each particular table. The base of a fixture or arbor to be used in connection with such a plug is provided with a counterbored hole as shown in the illustration above the plug. The operator first places the plug in the hole in the table, and then sets the fixture or arbor over it, as in the previous case. The method of locating fixtures outlined in the foregoing not only gives accurate results but also saves a considerable amount of time, as it eliminates the filing of keys which have become abused while the fixtures and arbors are in the tool storage.

The Efficiency of Worm-gearing[1]

By W. S. ATKINSON

It is quite generally understood that the efficiency of worm-gearing is determined by the lead angle of the worm thread, by the degree of mechanical excellence attained in its manufacture, and by the kind of lubrication provided. A superficial examination of the subject discloses these facts, and experience and tests confirm them, but it is important to know the definite relation of these features to the efficiency. In the formulas which follow,

n = revolution per minute of worm;
l = lead in inches;
ϕ = lead angle;
μ = coefficient of friction;
d = pitch diameter of worm;
P = pressure, in pounds, transmitted axially by worm to wheel;
R = pressure, in pounds, normal to wheel tooth.

Consider a worm and wheel in which the worm is driving. When the worm makes one revolution, a point at its pitch diameter moves axially a distance equal to the lead, and a point on the pitch circle of the wheel also moves this distance. When the worm makes n revolutions per minute and there is a pressure of P pounds transmitted axially by the worm thread to the wheel tooth, the useful work transmitted, in foot-pounds per minute, is

$$\frac{Pnl}{12} \qquad (1)$$

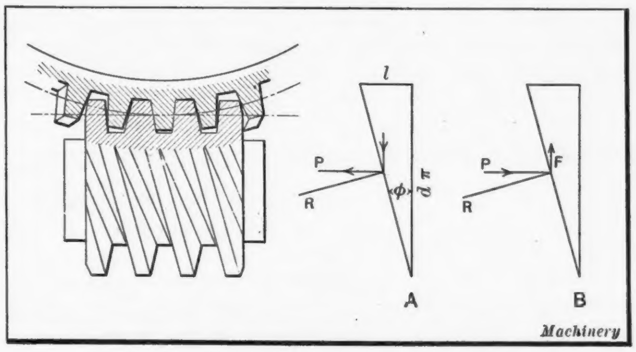


Diagram illustrating Conditions when Worm is the Driving Member and when Wheel is the Driving Member

The pressure normal to the wheel tooth is $R = P \cos \phi$ (see diagram A); the friction is $\mu R = \mu P \cos \phi$; and the work per minute against friction is

$$\mu P \cos \phi \frac{n\pi d}{12} \sec \phi = \frac{\mu P n \pi d}{12} \qquad (2)$$

The total impressed work then is

$$\frac{Pnl}{12} + \frac{\mu P n \pi d}{12} = \frac{Pn}{12}(l + \mu \pi d) \qquad (3)$$

The efficiency is the ratio of useful work, Formula (1), to impressed work, Formula (3), or

$$\frac{\dfrac{Pnl}{12}}{\dfrac{Pn}{12}(l + \mu \pi d)}$$

which reduces to

$$\text{Efficiency} = \frac{l}{l + \mu \pi d} \qquad (4)$$

Formula (4) is the expression for the efficiency of a worm and wheel with the worm driving. This expression can be further developed to show the efficiency as a function of the lead angle ϕ, and the coefficient of friction μ, by noting that

$$l = d\pi \tan \phi$$

which substituted in Formula (4) gives:

$$\text{Efficiency} = \frac{d\pi \tan \phi}{d\pi \tan \phi + \mu \pi d}$$

or

$$\text{Efficiency} = \frac{\tan \phi}{\tan \phi + \mu} \qquad (5)$$

From Equation (5) the accompanying table has been computed showing the efficiency for various lead angles, and coefficients of friction.

EFFICIENCY OF WORM-GEARING (THE WORM DRIVING)

Lead Angle, Degrees	Coefficient of Friction									
	0.10	0.08	0.06	0.04	0.02	0.01	0.008	0.006	0.004	0.002
5	0.466	0.522	0.594	0.683	0.813	0.897	0.915	0.935	0.956	0.977
10	0.638	0.688	0.703	0.815	0.898	0.946	0.956	0.967	0.977	0.988
15	0.728	0.770	0.814	0.870	0.930	0.964	0.971	0.978	0.985	0.992
20	0.784	0.819	0.858	0.900	0.947	0.973	0.978	0.983	0.989	0.994
25	0.823	0.853	0.886	0.921	0.958	0.979	0.983	0.987	0.991	0.995
30	0.852	0.878	0.905	0.935	0.966	0.983	0.986	0.989	0.993	0.996
35	0.875	0.897	0.921	0.945	0.972	0.985	0.988	0.991	0.994	0.997
40	0.893	0.913	0.933	0.954	0.976	0.988	0.990	0.992	0.995	0.997
45	0.909	0.926	0.943	0.961	0.980	0.990	0.992	0.994	0.996	0.998

Machinery

This table is instructive in showing the high efficiency attainable in worm-gearing when by careful machining and finishing and in the provision of adequate lubrication, the value of the coefficient of friction is kept low, and indicates the comparative difficulty of attaining the highest efficiency with low lead angles.

Efficiency and Torque when the Wheel is Driving

When the wheel is driving, the force is impressed at P and transmitted in the direction F, as shown by diagram B. The impressed force at F is $P \tan \phi$, and the work, in foot-pounds, in n revolutions of the worm is

$$P \tan \phi \frac{n\pi d}{12} \qquad (6)$$

The work per minute against friction is

$$\mu R \frac{n\pi d}{12} \sec \phi = \mu P \cos \phi \frac{n\pi d}{12} \sec \phi = \mu P \frac{n\pi d}{12} \qquad (7)$$

The useful work is

$$P \tan \phi \frac{n\pi d}{12} - \mu P \frac{n\pi d}{12} = \frac{Pn\pi d}{12}(\tan \phi - \mu) \qquad (8)$$

The efficiency is the ratio of the useful work, Formula (8), to impressed work, Formula (6),

$$\frac{\dfrac{Pn\pi d}{12}(\tan \phi - \mu)}{\dfrac{Pn\pi d}{12} \tan \phi}$$

Therefore

$$\text{Efficiency} = \frac{\tan \phi - \mu}{\tan \phi} \qquad (9)$$

[1]Paper presented at the fourteenth semi-annual convention of the Elevator Manufacturers' Association of the United States, Toledo, Ohio, October 27, 1920

or

$$\text{Efficiency} = \frac{l - \mu\pi d}{l} \qquad (10)$$

The available pressure at the pitch line of the worm (torque T at pitch line) and tending to turn it is

$$T = \frac{\dfrac{Pn\pi d}{12}(\tan\phi - \mu)}{\dfrac{n\pi d}{12}}$$

$$= P(\tan\phi - \mu) \qquad (11)$$

$$= P\left(\frac{l}{\pi d} - \mu\right) \qquad (12)$$

It will be noted that when the value of μ approaches that of $\frac{l}{\pi d}$ or $\tan\phi$ a comparatively great pressure P at the pitch line of the wheel is required to produce a torque in the worm, and when μ equals $\frac{l}{\pi d}$ or $\tan\phi$ no amount of pressure P at the pitch line of the wheel will produce torque in the worm, and the gearing is then irreversible or self-locking.

* * *

PRODUCTION WORK ON THE VERTICAL TURRET LATHE

A production job for which the vertical turret lathe is especially suitable is illustrated and described in this article. This machine, manufactured by the Bullard Machine Tool Co., Bridgeport, Conn., is shown in Fig. 2 engaged in finishing the exterior surfaces of a cream separator bowl at the plant of the De Laval Separator Co., Poughkeepsie, N. Y. This bowl is a steel forging made from acid open-hearth steel, a detail view of which is shown in Fig. 1. This illustration indicates by the dotted outline the amount of metal removed in finishing the bowl to the outline shown in full lines. The hole *H* is first bored with a tool held in boring-bar *A*, Fig. 2, this operation being performed while a tool held in the square side-head *B* is engaged in roughing surface *A*, Fig. 1, of the bowl. The next operation is that of rough-facing surfaces *B* and *C*, using a combination tool-holder shown at *C*, Fig. 2, while at the same time a forming tool held in the side-head, rough-forms the radius at the top of the bowl. It will be observed that the machine is shown taking these two cuts. The angular surface *D* is next roughed out with a tool carried in the third side of the turret, the compound feed of the machine being employed for this purpose. The fourth operation is that of finishing this angular surface, using the same tool but employing an increased rate of table speed. A tool-holder similar to that used in roughing surfaces *B* and *C* is next employed to finish these

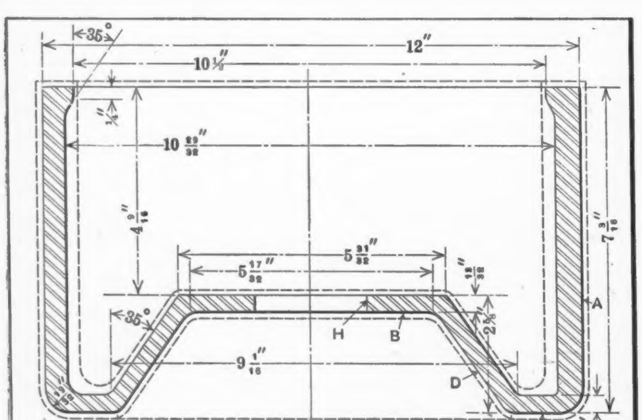


Fig. 1. Cream Separator Bowl finished on the Exterior on Machine shown in Fig. 2

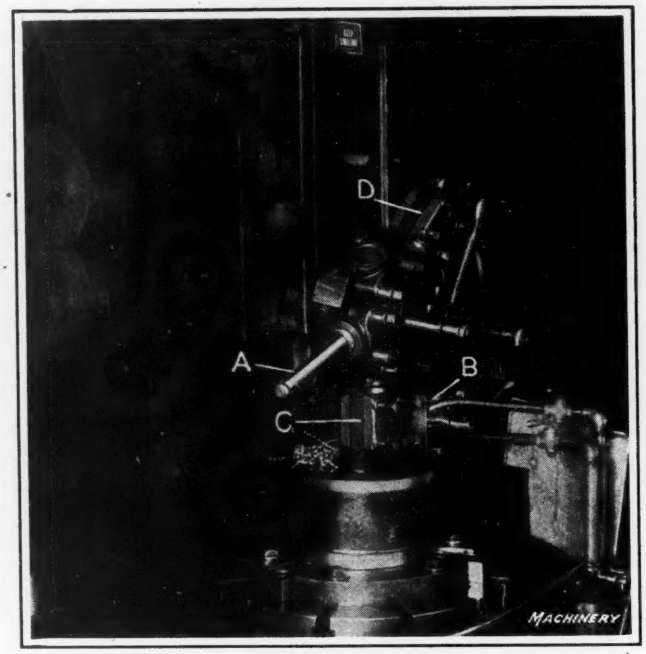


Fig. 2. Vertical Turret Lathe engaged in machining Cream Separator Bowl Forgings

surfaces, the tool-holder being shown at *D*, Fig. 2. While these surfaces are being finished, a forming tool held in the side-head is engaged in finishing the radius at the top of the bowl. The final operation performed is that of finish-turning surface *A*, during which the speed of the table is considerably increased.

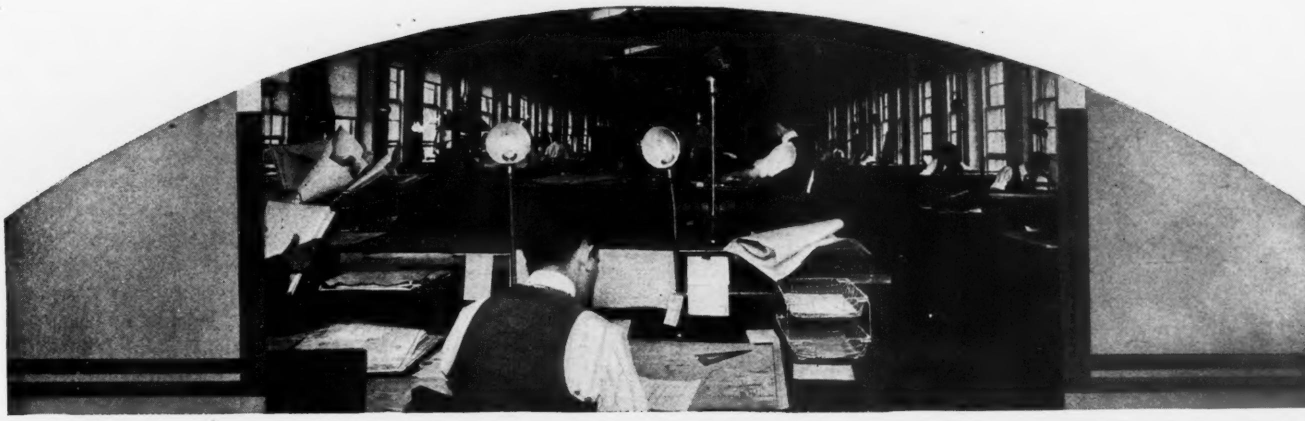
The production time on this job is fifty-two minutes, floor to floor, and thirty-five shells may be finished between grindings of the tools. A feed of 0.007 inch per revolution of the table is employed for the tools; and the velocity of the table during the roughing operations is forty revolutions per minute, and for the finishing operations, 60 revolutions per minute, with the same rate of feed.

* * *

ENAMELS FOR SHEET IRON AND STEEL

The enameling of sheet iron and steel has been treated in detail in a recent publication of the United States Bureau of Standards, entitled "Enamels for Sheet Iron and Steel," by J. B. Shaw. As little material has been published on this subject in the past, the pamphlet is an interesting addition to technical literature. From the standpoint of mechanical equipment, the sheet-iron and steel enameling industry has probably been the most progressive of all the ceramic industries in the United States. The presses and machinery used for working this steel and forming the shapes are very ingenious, and are constantly being improved. In the preparation and application of the enamels, however, progress has been less rapid. Up to a few years ago very little of this work was carried on, but recently there has been a decided change in this respect.

The material contained in the treatise represents a compilation of data from various publications; from the notebook of the author; from the files of the Bureau of Standards; and from the experience of men engaged in the enameling industry in this country. Among the subjects dealt with in connection with the properties and preparation of steel for enameling are physical and chemical requirements; sandblasting; treatment preliminary to pickling; and methods of pickling. A chapter is devoted to the properties of the raw materials used in compounding enamels. The relations between chemical composition and physical properties of enamels are discussed fully, and the procedure used in the preparation, applying, and firing of enamels is described in detail. The calculation of enamel formulas is fully explained. The physical properties of enamels are dealt with, and their resistance to chemical action is discussed.



Follow-up System for the Drafting-room

A System for Recording the Status and Daily Progress of Work During the Process of Manufacture

By JOHN A. HONEGGER

A FOLLOW-UP system bears the same relation to manufacturing as train dispatching does to the operation of a railroad. If a train dispatcher does not regulate the time between trains properly, or if the procedure of the trains throughout their runs is not followed, one of two things usually occurs: Either several trains run into each other, or they do not reach their respective destinations on time. The latter also holds good in manufacturing; without some method of recording the daily progress of each job, there is no assurance that orders will be delivered at the time promised. This is because the contractor cannot definitely state when the job will be completed if he does not know the standing of the various orders in the plant. From the foregoing it should be obvious that a proper follow-up system is just as important in building up a successful business as methods of routing orders through the various departments or inspecting the work when completed.

Developing a Follow-up System

In developing a follow-up system, consideration should be given to existing methods of handling work, to insure that the new system will not interfere with them or reduce their efficiency. The primary function of a follow-up system is to see that orders are kept progressing through the plant in such a manner that their delivery to the customer on time is insured. To this extent the system should have preference over every other part of the organization; otherwise the desired result will not be obtained. Numerous other factors must be considered before the system can be made operative; these, of course, vary according to the nature of the product manufactured.

When a system has been worked into definite shape, it should be carefully checked to find possible defects; the following points should be given careful consideration: (1) Can it be handled in a simple manner? The percentage of efficiency of any given action is rated upon the ease and accuracy with which it is accomplished; therefore, the less complicated a system, the more efficient it will be, provided it will produce the desired results. (2) Will it produce the desired results? This can be determined by applying it to situations that have occurred in the past. (3) What will it cost? (4) Is it fool-proof? (5) Will it interfere with any other system in use? (6) What advantage has it over the present system?

In regard to the third question, the greatest cost is obtained in working out the system; after that, printing charges mainly are involved. The answers to the fourth, fifth, and sixth questions can be determined by going over every detail of the system carefully and by making a practical application on a small scale. This practical application may also bring to light defects that otherwise might not be thought of. Taking the foregoing as a basis to work from, the firm by whom the writer is employed, devised a system for their engineering department, which has been in successful operation for over a year. This system, which is

OUR ORD. NO. – 342 DATE REC'D. Apr. 24-1920
CUST. ORD. NO. J-426 DATE PROM. May 29-1920
CUSTOMER A. B. C. Manufacturing Co.
ADDRESS 323 Ashland Ave. Rochester, N. Y.
WORK REQ'D. Drill Jig for Drilling 5-13/32" holes in Pump Housing - Stamp Tool No-157 Oper. C.
SAMPLES OR B/P FURNISHED Part Dwg. G-136-A Pump Housing

DATE	4-25-20	4-27-20	5-1-20	5-4-20				
DESIGNING	J.S.R.							
DETAILING			H.V.					
CHECKING		O.S.		J.S.				
REDESIGNING								

REMARKS:-

Machinery

Fig. 1. Form which is filled out in Triplicate when an Order is received, and during its Progress through the Drafting-room

DESIGNED 4-27-20
DESIGN CHECKED 4-28-20
SENT FOR APPROVAL 4-29-20
RETURNED APPROVED 5-1-20
RETURNED DISAPPROVED
REDESIGNED
REDESIGN CHECKED
CHANGES MADE
CHANGES CHECKED
SENT FOR REAPPROVAL
DETAILED 5-3-20
DETAILS CHECKED 5-6-20
JOB COMPLETED 5-6-20

Machinery

Fig. 2. Form stamped on the Back of the Triplicate Order Card to record Dates when Certain Work is completed

OUR ORD. NO. 342 CUSTOMER A. B. C. Manufacturing Co. CUST. ORD. NO. J-426
NAME OF TOOL Drill Jig for Drilling (5-13/32" Holes in Pump Housing D-136-A.
ASSEMBLY-DWG. NO. D-146 DATE COMPLETED 5-8-20

DATE	4-25-20	4-26-20	4-27-20	4-28-20	5-1-20	5-2-20	5-3-20	5-4-20	5-5-20			TOTAL
DESIGNING	8	8	1½									17½
DETAILING					5	8	7					20
CHECKING				5				8	2			15

Apr. 30-1920
May-5-1920

DATE												TOTAL
DESIGNING												
DETAILING												
CHECKING												

DATE												TOTAL
DESIGNING												
DETAILING												
CHECKING												

SUMMARY

17½ HRS. DESIGNING	@ 1.50	AMOUNT	$ 26.25
20 HRS. DETAILING	@ 1.00	"	20.00
15 HRS. CHECKING	@ 1.50	"	22.50
		"	
		"	
		TOTAL	$ 68.75

Machinery

Fig. 3. Card on which the Time consumed on a Job and the Costs involved are recorded and summarized

described in the following, can no doubt be modified to suit various other departments.

Follow-up System Used in an Engineering Department

The firm mentioned contracts for manufacturing a variety of work such as tools, fixtures, gages, special machinery, etc., and normally employs about twenty draftsmen. The forms used in the follow-up system are shown in the accompanying illustrations, and in order to make their use fully understood, it will be assumed that an order has been received, and this order will be followed through the office and the engineering department until it has been completed.

Immediately after the order has been received, the hour and date of receipt are stamped on it in some conspicuous space, usually at the top. The order is then sent to the order department, where several forms are filled out. First the order is entered in a book having forms such as shown in Fig. 1. There are six forms to the page and they are made out in triplicate, the first two being on bond paper and the third on a heavy paper similar to bristol-board. It will be noted that the first item on the forms is "Our Order No." This is put on so that the job can be identified at all times by this number. The remaining items are arranged according to their relative importance.

When the forms have been filled out, the duplicate and triplicate are detached and fastened together. The original form is left in the order book as a record. The back of the triplicate card is then stamped with a rubber stamp, as shown in Fig. 2, which is filled out when the work designated is completed. When a draftsman begins working on a job his initials and the date on which he started work are placed on the front of the card by the routing clerk. When the draftsman finishes, his initials and the date of completion are placed on the back of the card. By this method, if any trouble arises in the future concerning a particular job, reference to the order card of that job will show what men have worked on it. The main purpose of the forms, however, is to inform the chief draftsman where every job in the drafting-room is.

The second form to be filled out is the time and cost card shown in Fig. 3, which is used to summarize the time spent on the job and the costs involved. The items at the top of this card are similar to those on the order forms. The dates at the heads of the columns are filled in as the order is worked upon. It sometimes happens that when a job is sent to the customer for approval, it is not returned for several days, and if the dates were printed in the spaces, it would mean that a number of columns would have to be left blank. As it is, one column after the other may be used. The blank spaces beneath "Checking" are provided for any miscellaneous charges, such as extra blueprints, etc. The customer is billed from this card, and when a bill has been made out, a red line is drawn diagonally from beneath the charges to the date on which the bill was made out, as shown by the heavy dotted lines. The date of billing is then written or stamped along the diagonal line.

The next form to be filled out is illustrated in Fig. 4 and

JONES ENGINEERING COMPANY

				DESIGNING							REDESIGNING			
OUR ORDER NO.	ORDER ENTERED	DATE PROMISED	SENT TO ENG. DEPT.	AWAITING DESIGN	DESIGN IN PROGRESS	DESIGN READY FOR CHECKING	DESIGN CHECKING IN PROGRESS	DESIGN CHECKED	B/P SENT TO CUSTOMER	RETURNED APPROVED	RETURNED DISAPP'VD	SENT TO ENG. DEPT. FOR REDESIGN	REDESIGN IN PROGRESS	REDESIGNED
342	4/24/20	5-29-20	4/25/20	4/25/20	4/25/20	4/27/20	4/27/20	4/28/20	4/29/20	5/1/20				
343	4/25/20	6-4-20	4/25/20	4/25/20	4/25/20	4/30/20	5/3/20		Order cancelled-Part changed					
344	4/25/20	6-4-20	4/25/20	4/25/20	4/26/20	5/2/20	5/5/20	5/7/20	5/8/20					
345	4/25/20	6-4-20	4/25/20	4/25/20	4/26/20	5/2/20	5/4/20	5/6/20	5/7/20					
346	4/25/20	6-4-20	4/25/20	4/25/20	4/26/20	5/4/20	5/6/20	5/8/20	5/9/20	5/11/20				

Machinery

Fig. 5. Progress Card which is used by the Routing Clerk of the Drafting-room to record the Status of Various Jobs

is known as the "key card." The majority of customers desiring information as to the standing of an order, refer to the work by their own order number, and this key card, by giving the corresponding shop order number, saves much confusion in replying to such queries. These cards are filed alphabetically according to the name of the manufacturer. The time and cost cards are filed under the shop order number, while the duplicate and triplicate order forms and all drawings and samples submitted by the customer are sent to the engineering department.

CUSTOMER A.B.C. Manufacturing Co.
ADDRESS 323 Ashland Ave., Rochester, N.Y.

CUST. ORD. NO.	OUR ORD. NO.	CUST. ORD. NO.	OUR ORD. NO.	CUST. ORD. NO.	OUR ORD. NO.	CUST. ORD. NO.	OUR ORD. NO.
J-423	339						
J-424	340						
J-425	341						
J-426	342						

Machinery

Fig. 4. Key Card, giving the Customer's Order Number and the Corresponding Shop Order Number of the Manufacturer

Work of the Drafting-room Routing Clerk

Upon receipt of the order forms, the chief draftsman gives them to the routing clerk who enters the orders on a progress sheet, as illustrated in Fig. 5. This sheet is divided into the following main headings: Designing, redesigning, and detailing, which are subdivided into other headings to indicate the various stages in the progress of the work. The latter items are a combination of those on the front and back of the triplicate order card. The routing clerk fills in the first five columns from the information given on the order forms, after which the order forms are filed in the progress file. This file has a subdivision for each item contained on the progress sheet such as "Awaiting Design," "Design in Progress," etc., except those referring to the return of the work sent to the customer for approval. The forms are filed according to the status of the order, irrespective of the name of the customer.

It may seem unnecessary to have a redesigning section, but often the operations to be performed on a part or the design of the parts is so changed that a redesign of the tool is necessary. A filing cabinet is provided for the disposal of the drawings after the tool has been designed and while they are in the drafting-room, but are not being worked with. This cabinet has eight drawers, marked to suit the following conditions: "Design Ready for Checking"; "Design Checked"; "To be Redesigned"; "Redesign Ready for Checking"; "Redesign Checked"; "Awaiting Detailing"; "Details Ready for Checking"; and "Drawings to be Blueprinted."

All work is given out by the routing clerk and returned to him when completed. The chief draftsman concerns himself only with the manner in which the work is executed by the men and goes from board to board, making suggestions or giving instructions. In this way he is more likely to catch errors while the drawings are being developed. When a draftsman completes a job, he reports to the routing clerk, who consults the order file and selects another job for him. For instance, if a designer desires a new job, the routing clerk looks over all orders waiting designing and selects one that indicates the earliest delivery date. Then he obtains from the drawing cabinet the drawings and operation sheets submitted by the customer. He next gives the duplicate order form and drawings, etc., to the designer, enters the date and the initials of the designer on the triplicate order card, and files it under "Design in Progress." He also enters the date on the progress sheet in the column "Design in Progress." The duplicate order form remains with the job until completed.

When the designer has completed the drawings for the tool, he fills out a time sheet as shown in Fig. 6; however, such a slip is filled out daily if the job lasts longer than one day. Then, with the time slip, order slip, part drawings, and the completed design, he again reports to the routing clerk who files the design in the drawer containing designs ready for checking, removes the triplicate order card, marks the date in the proper place on the back, and files it under "Design Ready for Checking." He also marks the date in the proper column on the progress sheet. The order cards are moved toward the back of the file in each instance while the drawings are moved from the top to the next lower drawer, until both the cards and drawings, respectively, arrive at the final section and drawer.

The main purpose of the progress sheet is to permit the routing clerk to tell at a glance the standing of all jobs on hand; without it, it would be necessary to go through the various sections of the order card file before this information could be obtained. With this system, for example, if the A. B. C. Mfg. Co. wished to know the progress of its order J-426, it would only be necessary to refer to the key

PROGRESS SHEET

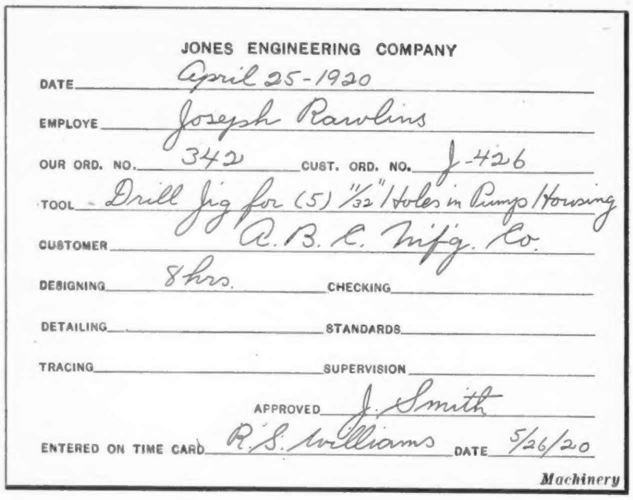
				DETAILING						
REDESIGN CHECKING IN PROGRESS	REDESIGN CHECKED	B/P SENT FOR 2ND. APPROVAL	REDESIGN APPROVED	AWAITING DETAILING	DETAILING IN PROGRESS	DETAILS READY FOR CHECK	DETAIL CHECKING IN PROGRESS	DETAILS CHECKED	ORDER COMPLETED B/P MADE	REMARKS
				5/1/20	5/1/20	5/3/20	5/4/20	5/5/20	5/6/20	Sent to Routing Dept. 5/6/20
see	new	part	drawing 1-562-J.							
				5/12/20	5/12/20					

Machinery

going through the Department so that the Chief Draftsman can tell at any Time what Progress is being made on a Job

card in Fig. 4 to find the corresponding shop order number to be 342. By referring to this number on the progress sheet, the desired information can be obtained.

When a job has been completed, the date of completion is marked on the back of the order card, and it is then sent to the time and cost clerk, who marks the card illustrated in Fig. 3 to suit. The billing clerk is then notified that the order has been completed, and the customer is billed for the remaining hours, the total cost of the job being carried under the summary. The assembly drawing number is marked on this card as information which may be of value on future jobs. A record print of the assembly drawing is also kept for the same purpose. It has been found advantageous to file the order cards and record assembly drawings according


JONES ENGINEERING COMPANY

DATE April 25-1920

EMPLOYE Joseph Rawlins

OUR ORD. NO. 342 CUST. ORD. NO. J-426

TOOL Drill Jig for (5) 11/32" Holes in Pump Housing

CUSTOMER A. B. C. Mfg. Co.

DESIGNING 8 hrs. CHECKING

DETAILING STANDARDS

TRACING SUPERVISION

APPROVED J. Smith

ENTERED ON TIME CARD R. S. Williams DATE 5/26/20

Machinery

Fig. 6. Time Slip filled out daily by the Draftsmen and upon the Completion of a Job

to the shop order number, and the time and cost cards under such headings as "Drill Jig," "Reaming Fixture," "Boring Fixture," etc. The drawings are folded and filed in the same manner as correspondence. Estimating future orders of a similar nature is made an easy matter under this system because of the data on hand. Costs and deliveries can also be given customers with some assurance that the jobs will be finished on time and at the prices estimated.

* * *

ELECTROMAGNETIC PROCESS OF REMOVING INTERNAL STRAINS

An electromagnetic process and apparatus for removing internal strains from forgings, stampings, and castings has recently been patented by Lars G. Nilson, Hoboken, N. J. The object of the invention is to provide a means of quickly and cheaply removing internal strains from gears, shafts, tools, cylinders, and other metallic articles which must retain their exact shape and dimensions as closely as possible, even if subjected to rough usage. It is a well-known fact that internal strains are set up in metal articles during forging, drawing, hardening, and casting operations; in fact, almost any operation which is commonly employed in the production of machine parts produces internal strains in the parts, or modifies existing strains.

Parts containing such internal strains naturally tend slowly to eliminate the strains at ordinary temperatures. This process of elimination is necessarily accompanied by changes in the shape or form of the part. Therefore to produce parts that will permanently maintain their accuracy, it is necessary that the internal strains be removed. In the case of castings the strains may often be sufficiently reduced to meet the requirements by seasoning, which is simply a process of setting the rough-machined castings away until the internal stresses have been practically eliminated by natural processes. This method, however, is slow and like the annealing and tumbling processes used for eliminating internal strains, does not meet present-day requirements of large manufacturers.

Briefly, the new process consists of subjecting the article to be treated to a powerful interrupted magnetic field, preferably an alternating electromagnetic field under such conditions of flux, density, time, and temperature as to remove internal strains quickly without affecting the desired hardness, tensile strength, or other desired characteristics of the article being treated. In the accompanying diagram is shown the general plan of an electromagnetic equipment, in which provision has been made for controlling the temperature of the part under treatment. The coil *A* is wound over a horseshoe shaped core *B*, and a tank *C* is placed between what would ordinarily be the poles of the core, the part to be treated being immersed in the tank. The tank can be filled with water, oil, fused metal or salt, or other liquid having the temperature desired for the combined drawing and magnetizing treatment, or combined cooling and magnetizing treatment.

Circulation is provided by a pump *D*, and cooling or heating is accomplished when necessary by the use of coil *E*, which is connected to the tank by pipes *F* and *G*. By means of this arrangement, hardened articles of steel such as milling cutters can be put in the tank and subjected to the alternating magnetic field without objectionable rise in temperature, since the temperature can be controlled by the circulation of the liquid to give the desired draw or to keep the eddy currents from raising the temperature.

Many articles made of high-carbon steel are spoiled during quenching, due to internal strains, and they often crack or warp a long time after being finished, in some cases even while in the store-room. It is claimed that treating such articles preferably just before the final grinding, or simultaneously with the drawing or tempering operation, insures a finished article which will be practically free from internal strains and which will permanently retain its finished form. The commercial value of this process lies in the fact that it saves much time and labor now required in manufacturing such products as high-grade machine tools

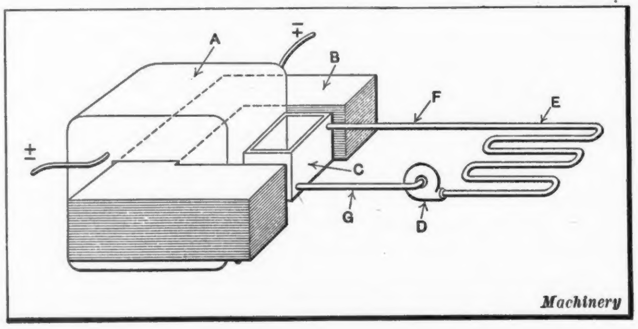


Diagram showing Arrangement of Electromagnetic Apparatus for removing Strains from Metal Products

intended for accurate work. Various modifications of the process and apparatus here described are made to meet special requirements. More complete information regarding the process and its special applications may be obtained from patent No. 1,335,453.

* * *

ANNUAL MEETING OF THE TAYLOR SOCIETY

The annual meeting of the Taylor Society will be held in the Engineering Societies' Building, 29 W. 39th St., New York City, December 2, 3, and 4. Public sessions will be held Friday and Saturday forenoon, afternoon, and evening. The subjects dealt with will be "Scientific Management in the Sales Department"; "The Long Day in the Steel Industry—a Problem in the Engineering of Men"; "The Standardization of Products"; and "Risk as a Retarding Factor in Production." The discussions will bring out the point of view of the manufacturer, the merchandiser, the industrial engineer, organized labor, and the consumer, each represented by a well-known speaker.

Increasing Production by Training Workers

Purposes and Principles Underlying the Establishment of a Training Department in the Plant of the Norton Co., Worcester, Mass.

By JOHN C. SPENCE, Superintendent Grinding Machine Division, Norton Co., Worcester, Mass.

EVERYBODY talks about the necessity for increased production and calls attention to the fact that the cost of living can be reduced principally by this means; but few definite proposals have been made whereby production can actually be increased. It seems to be the opinion of most of those people who advocate increased production that the increase should come merely by the worker doing more of his own accord, and little attention has been given to the duties and responsibilities of the management of an industrial plant in aiding the worker to produce more. In the following article the writer intends to point out some of the conditions that retard production, in the machine building trade especially, and to outline some of the principles that must be observed in making it possible for the worker to produce more.

In dealing with this problem, the open shop only is considered, because only in the open shop can the management freely aid the workers in increasing their production by means of proper training for the work to be done. In the closed shop the management is restricted in its efforts to aid the men in properly performing their work. It has to consult outside men, entirely removed from the industry, as to the number of people that may be trained and the method in which they are to be taught. The length of the period of training is prescribed; and, generally speaking, the constructive thought and ability of the management is absolutely nullified by the restrictions placed upon its efforts by union regulations, with the result that an arbitrary limit is placed, not only upon the worker's productive capacity, but upon his earning ability as well.

In the open shop, the management has a free hand to train the workers so as to enable them to earn good wages in a short period of time, and is also at liberty to provide any means and facilities whereby the production can be increased, and to adopt such rules and methods as will be equally advantageous to the employer and the employe.

Hiring Men from Other Plants versus Training Them Yourself

One of the practices in the management of industrial plants that has done much to decrease production, when the whole industry is considered as a unit, is that of hiring workers from other plants instead of obtaining untrained men and giving them the required training for the work to be done. Whenever a skilled worker is hired from another shop, there is merely a transfer from one shop to another, which does not in the least help the labor situation as a whole. The neighboring shop that loses its skilled men in this way is forced to adopt the same plan, and as likely as not will hire other workers from the first plant, so that there is ultimately merely an exchange of labor. Meanwhile, by these practices some of the workers who otherwise would have learned to stick to a worthwhile job have become rovers, because they find it easy to jump from job to job. This condition is a bad one for the men themselves as well as for the industry.

The only remedy in busy times is that of training unskilled help to perform whatever class of work is required. Those who have learned the fallacy of hiring men from their neighbors, and who years ago have adopted a plan of training their own help, know that intelligent, although inexperienced, men under proper conditions of training soon become better producers than the average men available in busy times who claim to have had previous experience in other shops.

To provide for proper training, it is necessary to have good teachers. Few people are good teachers. Out of twenty foremen it is seldom that more than one is a really good instructor. This means that in nineteen departments beginners do not have the opportunity to quickly become big earners both for themselves and for the company. It is therefore necessary to have a training department where all beginners pass through the initial training that one or more good teachers can give. This will insure uniform results. To provide such a department, it does not mean that it is necessary to purchase a great deal of new machinery and to incur great expense. As will be explained in a following article, the expense is nominal and will soon be more than balanced by the results obtained.

Scope and Advantages of the Training Department

A training department need not necessarily be confined to the instruction of inexperienced people. In busy times this, of course, would be its main object, but the true measure of the value of a training department is its work during a period of years representing a fair average of conditions. Almost any manager, superintendent, or foreman will admit that there is an advantage in setting up a training department when that scheme offers the only available means of obtaining more help; but, naturally, he wants to know what to do with the training department when the rush is over and help is more plentiful.

In order to answer this question, we must take into consideration the fact that in most plants there are several grades of work—some comparatively simple and others more involved. The machines doing the simpler work can be grouped together, and to these machines are routed the same class of work that they have been doing in the past, but they are used in a department by themselves as a starting point

for beginners, who are then promoted from this job to something more complicated in the main shop. A training department properly conducted should be run as a production department from the outset, because there are several distinct advantages to be gained thereby; first, it avoids the fear which the apprentice frequently feels when he is shifted from the training department to a "real job"; and secondly, men already employed in the shop, who are willing workers but whose efficiency falls somewhat short of the desired degree, may be placed in the training department for a brief period until they have obtained suitable proficiency in their work. While in the training department, they will still be employed on productive work, and there is no need of considering their time lost or their work unproductive.

The Duty of the Management in Obtaining Increased Production

In the open shop where the management has the power to arrange the work in the best interest of production, the main reasons for low production rates are: (1) Lack of tools or materials; (2) physical inability to do justice to the job; (3) lack of training; (4) lack of full information, even though the worker is trained; and (5) willful restriction on the part of the worker. For all of these causes, even the one mentioned last, the management is responsible. Each of these questions will be taken up in turn in this and following articles, and proper and effective remedies will be outlined.

Lack of Tools or Materials

It is unnecessary to point out that the management alone is responsible for lack of tools or materials; yet production is restricted in many instances because the important duties of the management in this connection are neglected. Tools and materials are not ready for the worker when he is ready to start on a new job. In too many places the decision as to what constitutes an economical supply of material to work upon and proper means for doing the work is made by someone who is a good bookkeeper, but who does not understand the productive processes in the shop and who does not know that men will work faster when there is plenty of work in sight and when the methods are such as to require the least amount of physical exertion. This subject has been dealt with extensively in the past, and employers are gradually beginning to see the necessity for more systematic means for providing the workers with the proper tools and materials for keeping production going.

Physical Incapacity for the Job

There are many instances where the worker is physically unfit to do justice to the job that has been given to him. Every industry should subject the workers to a physical examination before they are put to work, in order to determine that their health and strength is such that they are suited for the work they are expected to do. Such a physical examination, followed by proper medical attention after the employe has gone to work, has two advantages: It will prevent a man who is physically unfit for a certain class of work from being engaged upon it; and it will reduce the lost time due to sickness and injury. This has been proved in many shops where the practice of subjecting employes to a physical examination and of maintaining a shop hospital has been followed. On this subject also a great deal has been written in the past, and details are available for those who wish to study the subject further.

Lack of Proper Training

The most important factor of all, in the writer's opinion, is the lack of proper training, and it is with this factor that this article mainly deals. Quantity production and interchangeable manufacture have changed the conditions of production. Operators, rather than skilled mechanics, are employed on the general manufacturing work. In the interchangeable manufacturing industries, men are hired to "run" machines. They need not be skilled machinists, and for that reason the old-time apprentice system gradually has been discontinued. Even foremen are often drawn from the ranks of the operators, and in most cases these men have not had the advantages of the broader views that go with an all-around training.

Efforts are being made in some shops to revive the apprentice system, in order to supply the needs for future all-around machinists. In the writer's opinion all-around men can be trained quicker and better in a special training shop than they can be by old-time apprenticeship methods. Complete details will be given in this and following articles of the organization and methods used by the training school that was started by the writer in December, 1915, at the plant of the Norton Co. for the purpose of giving absolutely "green" help a few weeks of intensive training in the elements of work on the various common machine tools—the lathe, drilling machine, milling machine, grinding machine, and shaper.

It is not claimed that you can produce an all-around machinist in a few weeks; but it is claimed that in this short time a man can be trained to operate a certain type of machine tool very much more quickly than he could be taught to operate this machine under the old-time apprenticeship system. If he is successively trained in one type of machine tool after the other, with intervals of work on the same types of machine tools in the regular shop departments, he will at the end of two years be as good an all-around machinist as the apprentice who has received a four-year's training by the old-time apprenticeship methods, where he is at the mercy of the teaching abilities of the foremen and his fellow-workers in the shop.

Reasons for a Training Department

The reasons that led to the establishment of the Norton Co.'s training department may be briefly stated as follows: Good teachers are rare, and when one has been found who meets the requirements, all the beginners should be given the advantage of being taught by him. The best workman is not always a good teacher, and it is a waste of executive or productive ability to have high-grade foremen or producers instruct beginners, when this often can be done by men who are not as important in the productive organization. A high-grade foreman is likely to be a poor teacher, just the same as a professor of higher mathematics probably would fail in attempting to teach beginners arithmetic, because his training and habits of thought have put him entirely out of sympathy with those so far behind him in mental capacity.

The training department further insures that all the beginners receive the same kind of training, and this training can be regulated to the needs of the whole shop organization. The training department also affords an opportunity for teaching questions of corporation policy. It is possible in this way to make the employe understand his relation to the shop, and to the industry as a whole, and to teach him certain economic facts that even foremen sometimes do not appreciate. One of these facts is that the money with which the men are paid on each pay-day comes out of their own labor, and if they curtail production, they also decrease the fund out of which their wages are to be paid. When wages become too high in proportion to production, industry must stop, because no business can continue to operate in face of a loss.

The workers can also be taught to understand that the expenses of a business comprise more than the payment of wages to the men at the machines. The product made must be sold, and the money for the sold product collected, before there is anything wherewith to pay wages. It would be well if the workers in the industries had a little more appreciation of the difficulties involved in gathering together fifty-two pay-rolls every year. The training department offers an opportunity for teaching this and for counteracting the many false but popular theories of economics that are propagated. It provides an opportunity to teach the truth about the relations of the worker to the industry, and of the industry to the community as a whole.

What Does a Training Department Accomplish?

While, as already stated, it is not claimed that machinists or even high-class operators are made by the training method in the short time that each worker averages in the training department—about six or eight weeks—it has been established that it is possible to obtain a higher grade of boy or man to start to work in the shop when he is assured that he will receive an intensive training from the first. It has further been established that better workers can be produced in eight weeks in the training department than the employment department can hire, except, of course, in the case of the few skilled men who may apply for work. It has further been found that the graduates of a training department, when put into the regular shop departments, make better workers than those who have been put into the shop without training.

Results Obtained by the Norton Training Department

The best proof that can be given of the value of a training department is to record the results that have been obtained by the Norton Co. during the last five years. Records of results are always better than mere arguments in favor of a certain procedure. During the war, 65 per cent of the men employed at the Norton Co. were in the first draft, but thanks to the training school, new workers were trained at such a rate that the company was able to continue with an ever increasing production in spite of the fact that the draft board was compelled to be drastic in its rulings. At the time the armistice was signed, over one-half the workers in the plant had less than four months' experience, and 15 per cent of the total number of workers were women. Nevertheless, with only twice the number of employes in 1917 and 1918, compared with the number of employes in 1912 and 1913, the Norton Co. produced and shipped three times as many machines, and furthermore it is claimed that in these machines the quality of the pre-war period was not only maintained but improved.

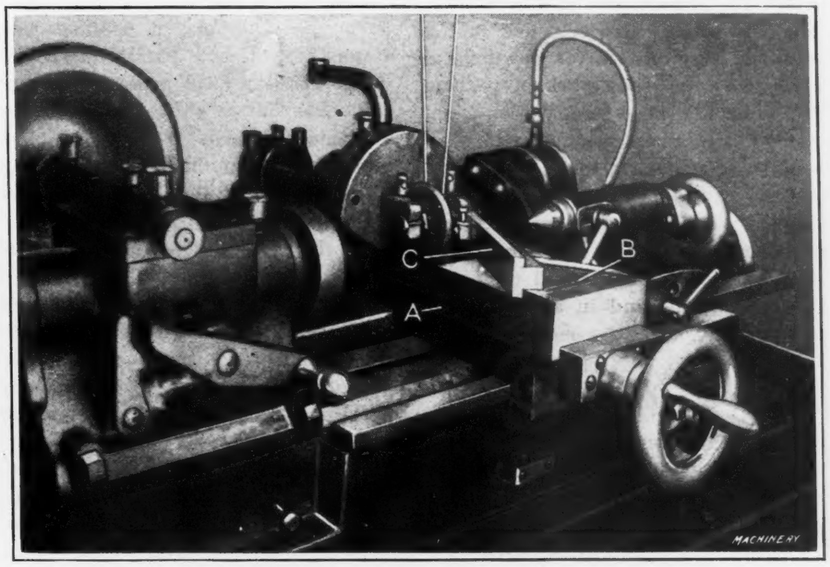
It should not be understood that all this increase in production was obtained through the efforts of the training department. In part it must be attributed to other causes, such as the improvement in the manufacturing departments and the encouragement of piece-work. More effort was made to provide drawings and operation sheets that gave complete information as to how the work was to be done, and by a properly conducted piece-work system, the employes were encouraged to work to the full extent of their ability without fear that the piece rates would be cut. This phase of the subject will be dealt with in a subsequent article. The actual organization and methods used in the training school will be dealt with in an article in the January number of MACHINERY.

* * *

Owing to the unprecedented levels to which prices of railroad cross-ties have risen in this country, and to the increasing scarcity of the North American wood used for this purpose, the Pennsylvania Railroad has decided to investigate the adaptability for this purpose and the relative cost of the hard woods of Central and South America. Under normal conditions the Pennsylvania Railroad System uses from five million to six million cross-ties annually.

THREAD GRINDING WHEEL TRUING DEVICE

The accompanying illustration shows a bench lathe equipped with a thread milling attachment, which has been adapted for the performance of a thread grinding operation in the shops of the H. E. Harris Engineering Co., Bridgeport, Conn. A special belt is carried down from a large pulley on the overhead works to a small pulley on the grinding wheel arbor, in order to obtain the high cutting speed that is necessary for efficient grinding. Evidently, a wheel that is used for grinding threads must have its cutting face formed to correspond with the included angle of the thread to be ground, and this result is accomplished by means of a special wheel-truing device. It consists of a block *A* that drops over the lathe cross-slide and has a V-shaped templet *B* formed on its upper surface. The entire top of the block is carefully machined, and a sliding bar *C* is arranged with a shoulder that fits on either side of the V-shaped templet *B*. With a diamond mounted at the forward end of bar *C*, it is a simple matter to reciprocate this bar back and forth along the angular sides of templet *B* to provide for truing the inclined faces of the grinding wheel to the desired form. Evidently, bar *C* must be turned over to place it on the opposite side of templet *B*, and this brings the diamond into the proper position for truing the opposite side of the wheel to that on which it is engaged as shown in the illustration. It will be noticed that there are two flanges on bar *C* which engage opposite sides of templet *B*.



Device used for truing Formed Wheels used for grinding V-threads

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The retarding effect of the shortage of coal on the rehabilitation and development of the French industries may be best understood by observing the fact that during the first half of this year there were only 18,000,000 tons of coal available for consumption in France, as compared with a consumption of 27,000,000 tons in the same period of 1913. In other words, the available supply at present, when the need is much greater, is only two-thirds the amount required in 1913. Of the present supply England has furnished 40 per cent; French coal mines, 37 per cent; and German mines, 13 per cent; while 10 per cent came from German districts occupied by the French. In 1913, 65 per cent of the French coal consumption was furnished by France, 21 per cent by England, 7 per cent by Belgium, 6 per cent by Germany, and 1 per cent was imported from other countries.

* * *

A comparison of performance of the motive power of the *New Mexico* with that of other battleships shows marked economy in favor of the electric drive, according to figures given in the *Sibley Journal of Engineering*. At 12 knots speed, the consumption in tons of oil per day was 75 for the *New Mexico* as compared with 100 for the cruising turbines and 118 for the main turbines of the *Arizona*, and with 99 for the cruising turbines and 115 for the main turbines of the *Mississippi*. At 19 knots, the consumption of the *New Mexico* was 263 tons; of the *Mississippi* main turbines 305 tons, and of the *Idaho* main turbines, 310 tons per day.

Industrial Notes from Germany

From MACHINERY'S Special Correspondent

Berlin, November 3

THE exposition or fair held in Leipzig this fall did not result in any appreciable business for the machine tool builders. This was due to many causes, partly to the fact that the engineering exposition was held at a different time from the general fair, and partly to the present economic situation of the country in general. The main interest in the engineering exhibition centered around the exhibit of the Association of German Machine Tool Builders, where many new developments were introduced, making it worth while for both manufacturers and designers to study the exhibition. The fundamental idea of the new developments is economy—economy of materials, economy of power, and economy in cutting time and labor attendance.

For the first time the German Government appeared at an engineering exposition as a commercial exhibitor. Die Deutsche Werke—the successors to those huge manufacturing plants of the German Empire, which were occupied in the manufacture of small arms and ammunition for the Government—are now entirely occupied on peace work of various kinds. Die Deutsche Werke include large steel works, foundries, machine building plants, establishments for making precision tools and instruments, chemical factories, and shops for repairing locomotives and railway cars. This combination of factories, owned and operated by the German Government, exhibited at the engineering exposition large machines for railway shops and ship building plants, small tools, fittings, screws and bolts, castings, etc., and in addition machinery for numerous industries not in the metal-working field.

Machine Tools at the Leipzig Fair

At the Leipzig Fair, turret lathes were more in evidence than engine lathes, and automatic turret machines were quite prominent. Cone-driven and all-geared lathes were shown to an equal extent. Auerbach & Son of Radebeul-Dresden exhibited a lathe having a novel micrometer device for accurately setting the finishing cut for reducing work to a given diameter.

Among the grinding machines, a shaft grinding machine exhibited by Naxos Union of Frankfort-on-Main attracted attention. In this machine, slender shafts 13 feet long are ground within limits of 0.0001 inch. A bore-grinding machine was exhibited for grinding holes up to 7 inches in length. This machine is provided with an automatic disengaging feed, which is set to throw out the feed mechanism when the exact size of bore has been reached. Surface grinders were exhibited by Schönherr of Chemnitz-Furth, making use of grinding wheels arranged in segments. All the surface grinders shown were equipped with magnetic chucks. Shapers were shown in great numbers. The travel of the ram of the largest Wotan shaper is 32 inches, with a transverse movement of the table of 40 inches. Eight different speeds are provided for the shaper ram, the maximum speed being 120 feet per minute.

Reinecker of Chemnitz exhibited a new automatic bevel gear shaper for the making of spiral bevel gears, this shaper being said to be a further development of the Bilgram type of machine. A new gear-cutting machine was exhibited by Max Röber & Co. of Chemnitz. This machine works on the slotting machine principle. The tool has teeth similar to that of a gear, and is rotated slightly, in conjunction with the gear being cut, after each stroke. Wire nail machines were exhibited by Malmedie & Co., of Düsseldorf, having an output of 500 wire nails per minute. Measuring instruments for the automatic recording of operation time were shown by Theodor Horn of Leipzig. The Zeisswerke of Jena exhibited a device for measuring the pitch diameter of threads by means of wires, and a new microscope for metallurgical investigations in the shop; this microscope permits the observation of the structure of a piece of metal without special preparation of the surface. Other machines exhibited were an electric rivet heating machine by the Mollwerke of Chemnitz, in which the rivets are placed in resistance in the current and thereby brought up to the required heat, and a weighing scale to be used for counting the number of small duplicate parts in a lot. This latter scale was exhibited by Wilhelm Wagner of Dresden.

General Conditions in the German Industry

One of the leading machine tool builders in Germany reports that the foreign business has practically come to a standstill, which is partly due to the fact that English and French buyers have made an agreement not to buy German machines, but to equip their factories either with domestic machinery or tools of American make. The same firm states that the domestic business in Germany continues to be quiet as the result of the high prices that make the placing of orders impossible.

Another machine tool builder reports that the last year has shown a decreasing buying capacity in the domestic market as well as a falling off in foreign business. In the early part of the year, the company's plant was busy mainly on foreign orders, but the foreign countries have now ceased buying, and the selling price of German machines now exceeds the price of machines sold by foreign competitors in the world's markets.

It is reported that the Soviet Government of Russia has placed orders in Germany for locomotives and woodworking machinery. The latter order, it is stated, is so secured financially that the German company that has taken it can go ahead without risk. It is expected that more orders will be received from Russia in the near future. Reports from Holland indicate that prices for German machine tools are now higher than those of tools from competing countries, and that buyers in Holland are now obtaining their machine tool requirements from countries other than Germany. The German machine tool builders claim that their difficulties are due to the fact that they have been unable to offer their machines at a fixed predetermined price on account of the constantly increasing costs of production and the fluctuations in the value of the mark.

Standards Committee of the German Industry

The German industries have created a standards committee similar to that which has for many years been engaged in standardization work in Great Britain and also to the one which has recently been formed in the United States. This committee is composed of representatives of the government, of the engineering and technical schools and institutions, and of the engineering and manufacturing societies. The object of the standards committee is to determine upon standards that are applicable either to the whole German industry or to some special trade or line of manufacture. The standards committee has already adopted 160 specific standards covering, among other things, standards for taper pins, reamers, threads, clamps, handles, wood-screws, parts of transmissions, ball-bearings, etc.

Plans for Importation of American Coal

Of the 470,000 coal miners in the Ruhr District, about 128,000 are engaged in mining coal for France, and it is stated that daily 77 trains, with 70 cars each, loaded with coal leave Germany. As a result, some of the largest iron and steel companies in Germany have had to cease operating their blast furnaces because of lack of coal, and the August Thyssen Metallurgical Works are said to be planning to import coal from America, in order to meet the urgent demands for fuel. Pig iron production has dropped from 19,300,000 tons before the war to 6,200,000 tons at the present time, and the outlook for the whole iron and steel industry is more serious than ever before. If the coal shortage becomes more acute, it will be necessary to cease the operation of a still greater number of blast furnaces and to shut down some of the steel plants completely. Should this come to pass, it will mean the breakdown of the whole economic life of Germany.

Investigation Work of the German Society of Engineers

In consequence of high wages and rising prices of raw materials, as well as the enormous taxes, German industry has been forced to seek means whereby these high costs may be compensated for by a reduction in the cost of production. For the solution of problems in this connection, the Society of German Engineers has engaged in far-reaching investigation work covering a number of different subjects, and is cooperating in this work with the leading societies of engineers and manufacturers in Germany.

The questions being discussed at the present time are as follows: The utilization of waste-heat from steam plants and from combustion engines and industrial furnaces; the development of cheaper methods for building houses; the scientific management of shop operations and the selection of an efficient working force; the development of the plan of interchangeable manufacture and the use of labor-saving machinery; standardization, and the elimination of unnecessary types of machines or classes of materials; and the specialization of each shop on a certain product that can be made by its equipment in the most economical manner.

Labor Conditions

The recent large strike in the industries of Wurtemberg ended with the complete defeat of the workmen and of the radical element. Terrorism in the shops has disappeared, and the workmen are now able to perform their work with greater efficiency. It is said that in the Bosch shops at Stuttgart and Feuerbach, the efficiency of the piece-workers has increased by 50 per cent as compared with the efficiency before the strike. The talking of politics during working hours, which was a habit acquired during the revolution, has become a thing of the past. The workmen have become convinced that they were deceived by the radicals. Owing to the depression in the industries, many of the plants have been unable to re-employ all the men that went on strike. The Daimler Works, for example, which employed 5000 men, are now operating with 3200 workmen, and state that conditions do not justify their employing even that number.

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CONFERENCE ON EMPLOYMENT AND VOCATIONAL EDUCATION

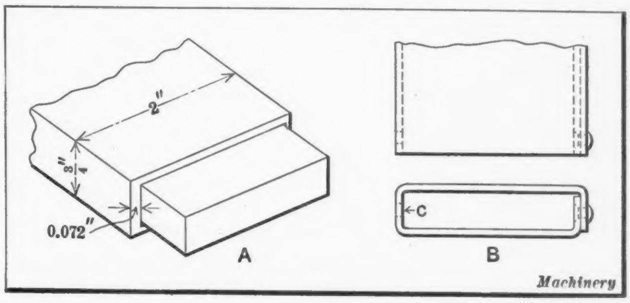
A conference on employment and vocational education was held under the auspices of the American Association of Engineers at the Congress Hotel, Chicago, Ill., November 12. Some of the subjects upon which addresses were presented were: "The Trend of Specialization"; "Placing the Graduate in His First Position"; "Fitting College Students for Success"; "Summer Employment for Men in Teaching Service"; "Employment Office Administration and Technique"; "Vocational Analysis and the Engineer"; etc. Four group meetings were also held, dealing specifically with employment management, employment bureaus, educational institutions, and general employment conditions.

INCREASING THE ENERGY OF A POWER PRESS FLYWHEEL

By DONALD A. HAMPSON

A certain manufacturer desired thousands of feet of special rectangular tubing of the dimensions shown at *A* in the illustration, which was to be so made that it would be possible to telescope a solid piece into the tubing without experiencing difficulty or excessive shake. Owing to the constant demand of the automobile industry for steel tubing material, it was impossible to find a manufacturer of this product who would contract to make the special tubing. Finally it was decided to produce the tubing on a power press by bending pieces of sheet steel to the desired shape, overlapping the two ends of each piece, and riveting them together as shown at *B*. The extra thickness and rivet heads along one edge were not objectionable, and as the tubes were to be used with one side up, the appearance was also satisfactory. Sheet steel of the proper gage and width was cut in lengths of from 5 to 14 inches as needed, preparatory to the bending operations.

Calculations were made to ascertain the approximate resistance of the stock to bending, and then the power press



(A) Rectangular Seamless Steel Tubing. (B) Tubing as produced on Rebuilt Power Press

available for the work was tested to determine whether it was capable of performing the operation. It was found to be constructed amply strong, but it was lacking in power as set up. By referring to the formula which is given on page 288 of MACHINERY'S HANDBOOK, for finding the energy given out by flywheels during the power stroke, it was seen that if the velocity of the flywheel and its weight were increased, the desired power would be obtained. Substituting another pulley for the cone on the press increased the velocity 30 per cent. The weight and mean diameter of the flywheel were then increased by bolting a steel railroad car tire weighing 190 pounds to the flywheel through the medium of three small castings and strap clamps. Later service proved the calculations and their application to be correct, as the power delivered to the ram was sufficient for the job.

The tubes were formed in four operations, two operations being necessary to make the U-bend at *C* and one each for the right-angle bends at the opposite edge. A mandrel of proper dimensions was used in the last two operations to form the tubing to the required size. Cast-iron punches and dies were employed on the press. It was first thought that these would have to be provided with steel faces; however, the first few proofs struck by means of the cast-iron tools were so satisfactory that more were made, and finally the entire lot was produced without any appreciable change of size. Due to a lack of spot welding equipment, it was necessary to rivet the joint at several points on each section of tubing. The rivet holes were countersunk on the inside by using a drill ground to the included angle of the rivet heads. It was necessary to drill through the opposite edge first, and so a jig with upper and lower guide bushings was employed, while a stop was used to terminate the lowering of the drill when the proper depth had been reached. The tubing as finally made was as cheap as the seamless product that was originally desired would have been, and its appearance and utility just as satisfactory.

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THE FORGING OF BRASS

Older text-books on engineering materials generally state that brass can be cast and rolled, but can be forged only with difficulty or not at all. During recent years there have been noteworthy developments in the forging of brass and other non-ferrous metals by shaping them to the desired form in dies under pressure. This process has two distinct advantages: First, it saves expensive material and decreases the labor cost as compared with that of castings which must be machined; second, it produces a better quality of brass, because the forging process condenses the metal and imparts additional strength thereto.

The leading article in this number of MACHINERY, "Making Brass Forgings," will prove of particular interest to metal manufacturers and engineers, because it deals with new developments in a comparatively new process in the metal-working field. The war speeded up developments in the brass forging industry, as well as in many other directions in the engineering field. The process of forging brass was applied during the war to the making of fuse parts, and has been gradually developed for the production of a great variety of parts employed for industrial purposes. One plant alone was producing 225,000 brass forgings for munitions daily at the time the armistice was signed, and the experience then gained has been since successfully utilized in the industries that are now turning out products for peaceful purposes.

* * *

PROGRESS IN STANDARDIZATION

From the viewpoint of national industrial economy the efficient use of the means of production already available is as necessary as the origination of improved methods of production. Among the many factors making for increased economy, none is more important than the careful standardization of engineering products. Commendable advances in this direction have been made in the electric motor field, and within the last three years the American Gear Manufacturers' Association has been very active in collecting information and in obtaining the opinions of manufacturers and users of gearing as a basis for establishing standardized practice. Great savings can be effected by rigidly adhering to carefully worked out standards. The duplication and waste resulting from lack of uniformity in manufactured products and methods of production is obvious.

Standardization has been objected to by some on the ground that it has a tendency to interfere with further progress, and it is true that when a product or a method has become standardized more serious thought is given to proposed changes than if no generally recognized standard were in existence; but it is doubtful if any meritorious change has ever been long delayed in the engineering field because of standardization. It has prevented many innovations lacking real merit. American engineers have never considered a standard as not being subject to change; but when a change is made, it should be agreed upon by virtually the whole industry concerned, and should not be inaugurated by a single manufacturer who may not have the best interests of the industry in mind.

The gear manufacturers should be commended for the splendid work they have already accomplished, which shows not only the great need for standardization, but also the practicability of harmonizing conflicting opinions when a determined effort is made to do so. The progress of the present work of standardization in the gearing field indicates that within a few years there will be a recognized uniformity in gearing practice throughout the country; and considering the widespread ramifications of that industry, this is a truly remarkable accomplishment.

* * *

APPRENTICESHIPS AND INDUSTRIAL RELATIONS

Various methods have been proposed and inaugurated for improving industrial relations and for developing a more cooperative spirit between employer and employe. Some of these proposals are practical and have proved their value; others look good in theory but have given but indifferent results in practice. There is one method that has never failed, and which is now being adopted more and more in the metal-working industries—the apprenticeship method.

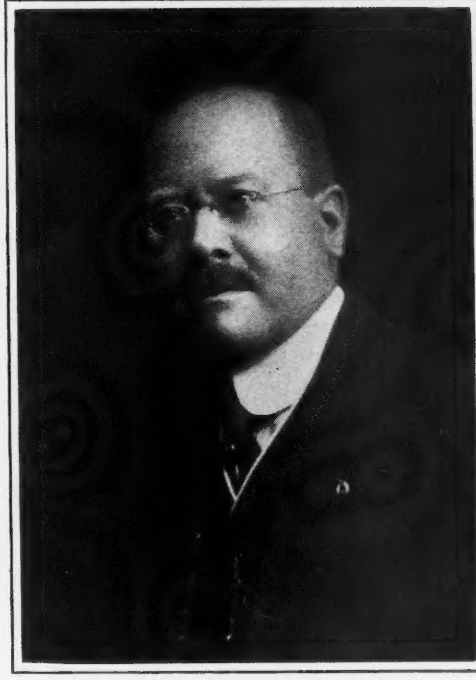
In general, apprenticeship systems are not looked upon as one of the means for improving industrial relations. Nevertheless, an intelligently conducted apprenticeship course does much to create a friendly feeling between employer and employe, not only for the present but for many years to come. The man who has been properly taught his trade becomes a skilled workman. A skilled workman is always at a premium and receives a higher wage than the man who has obtained his experience in a haphazard manner and who is, at best, an operator or helper. The intelligence of the skilled man has been more highly developed through the training he has received, and this, together with his better economic status, makes him less likely to fall a prey to the preachings of unsound economic doctrines.

To give young men an adequate incentive to strive for promotion, and to give them the means whereby they can improve their knowledge and skill in the mechanical trades, constitutes one of the best known means for producing satisfactory industrial relations. An apprentice who has been properly taught his trade realizes that the complete mastery of his work helps him to gain promotion and higher pay. He sees that in the long run it is skill, ability, and integrity that count, rather than affiliation with an association, the object of which is merely to secure equal pay for all men, irrespective of the great differences in their character, industry and working ability. During the apprentice period there is also an opportunity to teach the apprentice the truth that the slogan "Fair Pay" is only half of a complete statement. "Fair Pay for a Fair Day's Work," is the full statement, and where that is appreciated by employers and employes alike, there is no trouble about industrial relation

National Machine Tool Builders' Convention

THE National Machine Tool Builders' convention, held in New York City November 11 and 12, was attended by an unusually large number of machine tool builders, as the present condition in the machine tool industry made it desirable for the manufacturers to come together to discuss problems common to them all. Great interest was evidenced in the meetings, which were attended by a larger number of members than any the association has previously held, and the same was also true of the committee meetings.

At the opening session, the president of the association, A. E. Newton, in his address referred to the present situation in the machine tool building field, and reviewed briefly the conditions now confronting the industry, especially in regard to prices. President Newton's analysis of the situation and his conclusion that machine tool prices should not be reduced at the present represented the general sentiment of the convention. The important point was emphasized that prices must be regulated with reference to production costs, which have increased proportionately more than selling prices. It was mentioned that increased overhead costs have been the result of decreased output, and more than offset any decline in the costs of raw materials likely soon to occur.



A. H. Tuechter, Newly Elected President of the National Machine Tool Builders' Association

When considering this general question of prices, we believe that the basic nature of the machine tool industry and its importance to every manufacturer using metal-working tools should not be forgotten. In view of the fact that machine tools are used either directly or indirectly in the construction of every kind of mechanism, it is evident that developments in this field become a great national asset, but the development of the highly efficient machine tools now available represents an enormous outlay on the part of machine tool builders who are constantly making these costly improvements. The expense of this experimental and development work must necessarily be added to selling prices, and any reduction tending to arrest the progress of machine tool builders in constructing the most efficient tools possible, would be "penny wise and pound foolish" for the manufacturers who need, more than ever before, the best equipment that brains and money can produce. A few hundred dollars difference in the original cost of a highly efficient machine tool becomes insignificant when compared with the enormous gain resulting from the use of such a machine throughout the period of years representing its life.

Among the other addresses at the convention was one by D. R. Weedon of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., on the subject of "Standardization," which related exclusively to the question of motor applications to machine tools. In this address the different types of motor drives suitable for various classes of machine tools were reviewed, and many points to be considered in the application of motors to machine tools were brought out. The fact was emphasized that standard designs covering the installation or application of drives, the style of control, and ratings, are practicable, and that considerable benefit can be derived by applying the same general types of electrical apparatus to the same general types of machine tools.

F. A. Foster of Peking, China, who at the present time is spending a few months in the United States, spoke on conditions in Chinese machine shops, and showed a number of interesting lantern slides illustrating the equipment and arrangement in Chinese shops. He also made special reference to the need for training schools in China and their value in introducing American machine tools in Chinese industries.

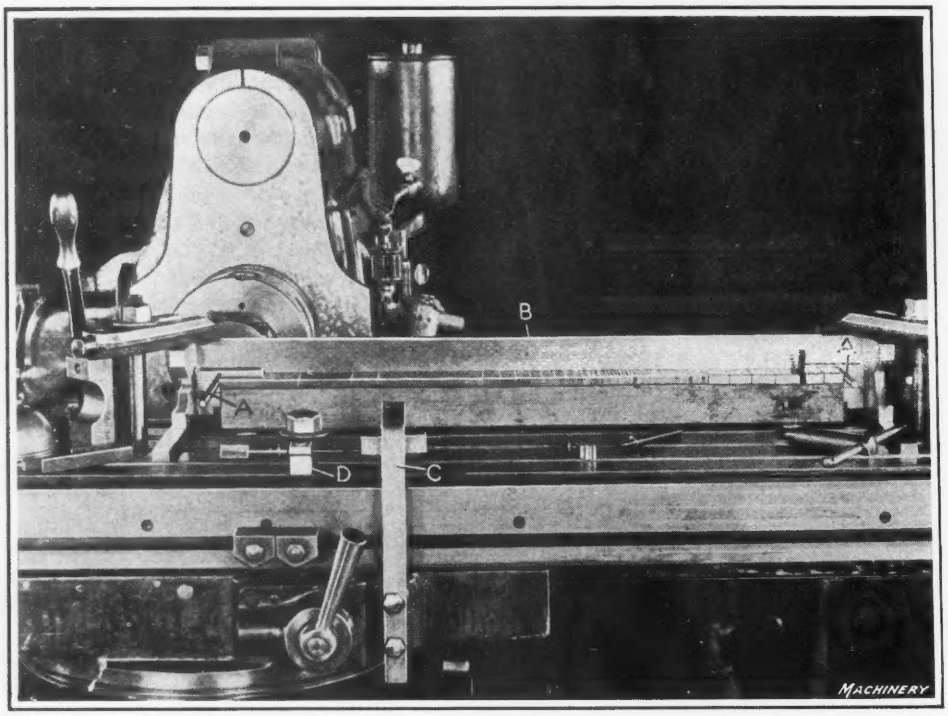
Financial conditions as affecting business were discussed in an address by Francis H. Sisson, vice-president of the Guaranty Trust Co. of New York City. In an unusually concise presentation Mr. Sisson dealt with the subject of the restriction of credits that has been necessarily exercised by the banks, and pointed out that although the banks at present have restricted credits, they have made loans to assist the industry in amounts greater than at any previous time in the history of American banking. He explained that the restrictions made were for the best interests of the entire industrial and commercial field, and that there necessarily had to be a period of liquidation after the period of expansion and inflation that the whole world has passed through industrially and commercially during and since the war. With regard to the future, Mr. Sisson spoke with optimism, but advised caution. He stated that normal business conditions could not be expected until price adjustments had brought prices to a level where there would be no further inflations of values, and where normal business on a permanent basis could be carried on. The foreign trade situation was also given attention, and it was pointed out that the foreign exchange could never be expected to return to normal until the production abroad reached a point where sufficient goods would be imported into this country to pay for exported goods.

An address by W. Randolph Montgomery that aroused a great deal of interest dealt with cancellations of orders. One of the important points brought out in this address was the difference in the laws covering contracts in different states. It was shown how a contract legal in one state may be entirely beyond the jurisdiction of the courts of another state. E. W. McCullough, manager of the Fabricated Production Department, U. S. Chamber of Commerce, gave an interesting account of the experience of the U. S. Chamber of Commerce in investigating the matter of cancellations.

The third session of the convention was devoted entirely to committee meetings. At the fourth session, officers for the coming year were elected as follows: President, A. H. Tuechter of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio; first vice-president, E. J. Kearney, of the Kearney & Trecker Co., Milwaukee, Wis.; second vice-president, C. Wood Walter, of the Cincinnati Milling Machine Co., Cincinnati, Ohio; secretary, Carl F. Dietz, of the Norton Co., Worcester, Mass.; and treasurer, Winslow Blanchard of the Blanchard Machine Co., Cambridge, Mass. Charles E. Hildreth, of Worcester, Mass., remains general manager of the association.

LAYING OUT BUSHING HOLES IN SPECIAL DRILL JIG

In making a drill jig for drilling two 1/8-inch holes in tabular carriage stop racks for the Remington Typewriter Co., the Marvin & Casler Co., Canastota, N. Y., employs the following method for laying out the drill bushing holes. The operation is of special interest in that the spacing of the holes is greater than in most drill jigs, and in locating these holes an exceptionally long stack of Johansson gage-blocks was necessary. The accompanying illustration shows the job after the holes were bored, and gives an idea of the number of blocks that is required to check the distance between the two locating studs *A*. The distance between the drill bushings must check to 24.02 inches. In laying out the holes, the jig *B* is first strapped to the table of a No. 2 Cincinnati milling machine, and the right-hand hole located 1.56 inches from the end and aligned with the milling machine spindle, preparatory to boring, by means of a rotary center indicator. It is the locating of the second hole that makes this job especially interesting.



Set-up for checking Center Distance of Two Drill Bushing Holes in Drill Jig for Typewriter Part

With the table still in the position occupied during the drilling of the right-hand bushing hole, use is made of a Koch indicator carried on strap *C* and a micrometer spindle mounted in a parallel block *D*, for establishing an accurate registry point from which to locate the table to the right a distance of 12.01 inches, or one-half the total distance between the drill bushing holes. The reason for moving the table only one-half the distance at a time is that it was not thought that the accuracy in lead of the table feed-screw should be depended upon to obtain such a long and exact setting. The length of the jig is so great that nearly the entire length of this table screw is utilized in moving the table from one end to the other, and as there is likely to be a variation in lead caused by wear on the central portion of the screw, gage-blocks are employed to check the table movement obtained by using the graduated dial of the milling machine.

Then, with the micrometer block carrying the spindle secured on the milling machine table, and the end of the spindle in contact with the indicator point, both registering zero, a stack of gage-blocks is laid on the table, abutting against the left-hand side of the micrometer block. This stack of gage-blocks is such as to enable the micrometer spindle block to be relocated exactly 12.01 inches to the left of its original position. By this means, any cumulative error which exists in lead in the table feed-screw may be compensated for in obtaining this second setting of the table, by simply adjusting the micrometer spindle so that when it is in contact with the indicator point, zero registration will be obtained. This procedure of locating the micrometer block one-half the total spacing of the drill bushing centers is then repeated, so that the final setting should be as accurate as modern jig making methods are capable of producing. The second hole is then drilled and a locating stud driven in, so that the over-all distance between centers may be checked. For doing this, a parallel is placed as shown in the illustration so that gage-blocks may be supported between the locating studs.

By following this method of locating there can be no theoretical error, but if slight discrepancies occur between the spacing obtained and the over-all dimensions of the blocks, they can, of course, be easily rectified by reboring the last drilled hole, using an off-set boring head such as the milling machine shown in the illustration is equipped with. This is a Marvin & Casler product and contains a bushing graduated to thousandths of an inch, by means of which the tool may be offset any desired amount. The question may be raised as to why the table was not located in a single setting, using the complete stack of gage-blocks, rather than splitting them up and making extra work. The reason for this, however, will be at once apparent when it is realized that a stack of blocks 24 inches long would be composed of so many units that there would be a possibility of their bulging or springing slightly near the center. In the case of a shorter stack, of course, this would be less likely to take place, and consequently the likelihood of error would be proportionately reduced.

* * *

OIL-FIRED LOCOMOTIVES

Extensive tests have been made in France of the use of residuary oil as locomotive fuel, and as a result it is stated that the Paris-Lyons-Mediterranean Railway has decided to convert two hundred of its engines so that this kind of fuel can be employed. The main advantages which the tests showed to be secured are as follows: About 20 per cent more steam is raised as compared with coal fuel; space is economized; stoking is eliminated, as the oil flows automatically; and the fuel is easily taken in. These advantages would probably result in a material saving in running costs. An incidental benefit accruing from the use of oil is the fact that an oil fire gives off little smoke, and therefore the workshops and sheds can be kept cleaner. Similar tests have been made in Italy with much the same results, and British railway companies are said to be seriously considering the possibilities of oil firing. Among those taking an active interest is the London & Northwestern Railway Co., which recently completed a six months' test with one of its locomotives that had been converted for the purpose, and it is understood that the results were very satisfactory. These tests are of particular interest at the present time in view of the general shortage of coal and the difficulty of mining the required amount to meet the demand of the industries all over the world.

American Gear Manufacturers' Convention

THE convention of the American Gear Manufacturers' Association held at Lake Mohonk Mountain House, Lake Mohonk, Ulster Co., N. Y., October 27 to 29 was marked by the same active and progressive spirit that has characterized all the former conventions of the association. Practically the entire time of the meeting was devoted to reports on standardization of various types of gearing, and to discussion of these reports. Addresses were also made on the subject of standardization by P. G. Agnew, secretary of the American Engineering Standards Committee, and by Calvin W. Rice, secretary of the American Society of Mechanical Engineers. At one of the meetings Christopher Haigh, supervisor of costs of the General Electric Co., Schenectady, N. Y., spoke on "Machine-hour Rate Method of Distributing Manufacturing Expense." This paper is reproduced on page 370 of the present number of MACHINERY. C. L. Collens, president of the Reliance Electric & Engineering Co., Cleveland, Ohio, made an address on "Industry Organization," outlining the principles that should govern a successful association of manufacturing plants within a given industry that aims at reducing costs and increasing production by standardization.

The Significance of Standardization

The subject of Mr. Agnew's address was "Standardization from the Point of View of the American Engineering Standards Committee." The speaker pointed out that the first national engineering standardizing body was a British organization formed in 1902, which has been an important factor in the development of the British industries. During and since the war, national engineering standardizing bodies have been formed in Austria, Belgium, Canada, France, Germany, Holland, Sweden, Switzerland, and the United States, and similar bodies are now being formed in Italy and Japan. The organization in this country—the American Engineering Standards Committee, 29 W. 39th St., New York City—was organized in 1918, but has been engaged in active work for less than a year. The functions of this committee are to promote and coordinate standardization work on a national scale and to serve as an authoritative channel of cooperation in international standardization. As an illustration of work now under way, two or three examples were mentioned. At the request of the British Standards Committee, a standardization body representing American steel manufacturers, the American Society of Civil Engineers, the Society of Naval Architects and Marine Engineers, the United States Navy, and other bureaus and associations is now at work to secure an Anglo-American agreement on the cross-sectional shapes of structural steel. At present, there are in American practice two nearly independent series of sections, one for general structural purposes and one for ships; and it is proposed to simplify the matter greatly by reducing them to one systematic series. From Belgium has come a proposal for an international standard on zinc ores and zinc products. A comprehensive program of industrial safety codes is under way. In the past, there have been more than 100 organizations engaged in the formation of safety codes without any systematic cooperation. Hence duplication and confusion have been the result. In extreme cases there were devices manufactured conforming to regulations in one state, the use of which were prohibited by the regulations of another.

Objects of Standardization

In the course of his paper Mr. Agnew pointed out that standardization, if carried out on a sound engineering basis, enables buyer and seller to speak the same language; promotes fairness in competition, by putting bids on an easily comparable basis, both in domestic and foreign trade; lowers unit costs by making mass production possible; simplifies the carrying of stocks and makes deliveries quicker; eliminates indecision both in production and utilization; and decreases selling expenses, one of the serious problems of our economic system.

It was also pointed out that the standardization work in Germany has been carried on since the end of the war with great activity. In two years' time the German committees have published 160 standardization sheets and have 240 other standard sheets under consideration. The Swiss, German, Dutch, and Swedish standardization committees have split up their work into very small sections in order that a branch industry may quickly agree upon a standard for a certain kind of work even when the broad aspects of the standardization work in the trade cannot be completed at as early a date. It is better to get the standardization work under way in a small measure than to wait until the last word is spoken on every possible phase of the subject. The tendency in Great Britain during the eighteen years of standardization work has also been to split the work into smaller sections.

In his talk on standardization, Mr. Rice called attention to the pioneer work done by the American Society of Mechanical Engineers in standardization work, and pointed out how important this work is for the proper development of the industries. It was mentioned that the government of Great Britain has appropriated $5,000,000 for standardization work. In this country different conditions made it impossible or inadvisable for the government to appropriate for the purpose of standardization in the industries, but the manufacturers here must do the work themselves, and in so doing will greatly benefit the industries of the whole nation. Mr. Rice outlined the great variety of standardization work that has already been done by the American Society of Mechanical Engineers and pointed particularly to the Boiler Code as an example of what can be accomplished by concerted effort.

Report of Standardization Committee

B. F. Waterman of the Brown & Sharpe Mfg. Co., Providence, R. I., as chairman of the general standardization committee of the American Gear Manufacturers' Association, presented a report in which he reviewed the work done so far along the lines of standardization by the association. He pointed out that a standard for composition gearing had been adopted and that the report on gears and pinions for electric railway service had been accepted as recommended practice. A part of the report on bevel gearing has also been adopted as recommended practice by the association, as well as a report on limits for holes. Committees are now active on standardization work relating to spur gears, bevel gears, sprockets, herringbone gears, worm-gears, electric railway and mine gears and pinions, hardening and heat-treating, inspection, and keyways. In addition, the library committee has been active in compiling material bearing on the subject of gearing and gear-cutting practice.

Mr. Waterman also made a report on the work of the sectional committee of the American Engineering Standards Committee, the duties of which are to work in connection with the national committee for adopting American engineering standards. The object of the cooperation with the Engineering Standards Committee is to work in conjunction with that and other engineering bodies with the view to formulating engineering standards, and thereby avoid the duplication of standardization work and the promulgation

of conflicting standards. The American Gear Manufacturers' Association has appointed a committee consisting of B. F. Waterman, J. B. Foote, H. J. Eberhardt, J. C. O'Brien, A. C. Gleason, and A. W. Copland. This committee will cooperate with a committee appointed by the American Society of Mechanical Engineers to consider gear standards of general interest with the idea of presenting them to the American Engineering Standards Committee for approval and ultimate adoption as American standards.

Report of the Spur Gear Committee

The spur gear committee, of which Frank E. Eberhardt of the Newark Gear Cutting Machine Co., Newark, N. J., is chairman, presented a report showing the progress of the work of the committee. This report also indicated the general tendency in practice, as determined from the answers received to a questionnaire sent out to the members of the association. The replies received indicated that the 14½-degree involute tooth is considered standard in the gearing field, unless otherwise specified. When a 20-degree pressure angle is used, the tooth dimensions employed vary. Some manufacturers employ the same dimensions as for the 14½-degree tooth, and some use the Fellows stub tooth. When using a stub tooth, the majority of the manufacturers appear to use the Fellows 20-degree stub tooth, while others use a number of special formulas.

An interesting question related to the width of the face with regard to the pitch. While the answers to this question showed some variation, the most general practice is simply to make the width of the face approximately equal to three times the circular pitch. With regard to the total thickness of the rim in relation to the diametral pitch, no uniform practice is in existence. The thickness varies with different manufacturers from 3.8 divided by the diametral pitch to 4.3 divided by the diametral pitch. The maximum thickness between the bottom of the teeth and the keyway in present practice also varies, and the proportion of the arms is not standardized. The diameter of the hubs with relation to the bore also shows some difference in practice, but the general usage is to make the diameter of the hub equal to twice the bore. The most generally used formula for the horsepower transmitted by spur gears is the Lewis formula, but there is some tendency to use the Lewis-Barth formula. As to many other questions relating to spur gearing, it was found that no generally accepted standard is followed by all makers, and the committee is endeavoring to formulate such standards and to present a complete report for adoption at some future meeting of the association. The idea is not to create any new standards, but to standardize existing usage whenever that is possible.

Standards for Worm-gearing

The committee on the standardization of worm-gearing of which J. C. O'Brien, of the Pittsburg Gear & Machine Co., Pittsburg, Pa., is chairman, brought in quite a complete report dealing with some of the important phases in worm-gearing, particularly with the nomenclature and symbols that ought to be used in worm-gearing formulas and calculations. Through the discussions at previous meetings, the committee had established the fact that the advisability of adopting the diametral pitch system for worm-gearing was questionable, as the only advantage of the diametral pitch system over the circular pitch system for worm-gearing would be the ease with which the pitch and throat diameter of the worm-wheels could be calculated. On the other hand, it was pointed out that there are several advantages in the use of the circular pitch system for worm-gearing, important among which are the ease by which the leads of worms may be obtained exactly by the use of simple gearing, while, when using the diametral pitch system, an approximate lead is generally employed, having a slight error. Makers of worm-gearing report that from 90 to 95 per cent of existing hobs are made in accordance with the circular pitch system. The committee stated that it thought the question of pitch systems for spur gears had been confused with that of worm-gears, and pointed out that because the diametral pitch system is better in the case of spur gears, it could not be assumed without further investigation to also be better for worm-gearing. Each case must be judged upon its merits.

With regard to the nomenclature and symbols to be used in designating parts and dimensions of worms and worm-gears, the committee reported that there were four systems of nomenclature and symbols possible, as follows:

1. A system in which the various quantities are written out and the formula stated in full.
2. A system in which the various quantities are abbreviated, as, for example, using the abbreviation "add." for addendum, "p. d." for pitch diameter, etc.
3. A system in which the various quantities are represented by single letter and sub-letter, as, for example, p_c for circular pitch.
4. A system in which the various quantities are represented by single letter symbols with primes instead of sub-letters, as, for example, d' for the pinion diameter, p' for circular pitch, etc.

As the fundamental object of symbolic representation is to make it possible to express rules and formulas in as condensed a form as possible and one in which the reader can easily remember the meaning of the various symbols, the committee recommended System (3), in which all quantities are denoted by single letters and sub-letters. Sub-letters may be so arranged that the reader, after becoming acquainted with the general scheme of nomenclature, will be able to understand the meaning of the symbols in the formulas without having to refer to a key to the symbols.

Report on Composition Gearing

In the report of the committee on composition gearing, of which John Christensen of the Cincinnati Gear Co., Cincinnati, Ohio, is chairman, an interesting historical sketch of the development of composition gearing was given. The history of composition gearing covers a period of from thirty-five to forty years. As cut gearing became more predominant, the noise produced by the higher pitch line velocities of metal gears demanded a silent factor in the transmission of power at a positive ratio. In the early stage, common fiber, hard rubber, leather, etc., were tried, but did not at that time fully meet the requirements of an ideal silent drive. However, the use of dried rawhide led to the development of the rawhide gear, and in recent years, hard fiber, fabroil and bakelite micarta have been used to advantage, all of which have proved very satisfactory elements in silent transmission. The rawhide pinion dates back to the seventies, and its origination is claimed by the Chicago Rawhide Mfg. Co., Chicago, Ill., a member of the association.

The story of the discovery of its use for this purpose is as follows: In the early history of the Chicago Rawhide Mfg. Co. the United States Government was being furnished, upon a small contract, with dry flint rawhides for chair seating purposes. At that time, the company had in its employ as Chicago city salesman, Captain D. R. McCutcheon, a veteran of the Mexican and Civil Wars, and a man of inventive and progressive mind. Captain McCutcheon, who was naturally looking for any possible outlet for the products of the company among the manufacturers of that city, one day encountered a customer to whom he had been selling rawhide belting and who was greatly annoyed by the racket of a metal gear and pinion in operation on one of his machines. Captain McCutcheon, realizing that hard flint rawhide was extremely strong of fiber and durable, conceived the idea of cementing together several layers of this rawhide, thus making a rawhide blank, from which a pinion was constructed and delivered to his customer. The experiment proved highly successful and the rawhide pinion gave good service. This, according to tradition, was the first rawhide pinion ever made.

Report of Keyway Committee

The committee on keyways, of which Henry J. Eberhardt of the Newark Gear Cutting Machine Co., Newark, N. J., is chairman, reported that average shop practice appears to agree fairly well with tables of keyways given in various handbooks. The committee recommended that for certain diameters of shafts, and in the absence of specifications to the contrary, the keyways should be of a width equal to one-quarter of the shaft diameter, and the depth should be equal to one-half the width, and measured at the side of the keyway. In order to avoid many and odd sizes of key stock, the committee submitted a table of diameters and corresponding sizes of keyways from 5/16 inch to 12 inches diameter of shaft. The report will be submitted at a later meeting of the association for acceptance, and when approved as an American Gear Manufacturers' Association standard will be published in detail.

Report by the Inspection Standardization Committee

E. J. Frost of the Frost Gear & Forge Co., Jackson, Mich., as chairman of the inspection standardization committee, made a complete report on the subject of standardization. This report related to the inspection of cylindrical holes, tapered holes, straight keyways, Woodruff keyways, tooth bearings, splined shafts, and dealt also with the design of test stands and fixtures for testing gears and tooth shapes.

Reports were also presented by A. C. Gleason of the Gleason Works, Rochester, N. Y., for the bevel and spiral bevel gear committee; by C. R. Weiss of the Link-Belt Co., Philadelphia, Pa., for the sprocket committee; by R. L. Dodge of the New Process Gear Corporation, Syracuse, N. Y., for the hardening and heating committee; and by A. F. Cook of the Fawcus Machine Co., Pittsburg, Pa., for the herringbone gear committee. The committee on electric railway and mine gears and pinions, of which W. H. Phillips of the R. D. Nuttall Co., Pittsburg, Pa., is chairman, also presented a report. The commercial side of the association's activities was represented by the report on Uniform Cost Accounting presented by J. H. Dunn of the R. D. Nuttall Co.

Resolution on Industrial Relations

The association adopted a resolution endorsing the principles laid down by the Philadelphia Chamber of Commerce on industrial relations. These principles are as follows:

1. Employment relations should recognize and conform to those principles of individual liberty, freedom of contract, and equality of opportunity that form the basis of our national institutions.

2. The right of open shop operation, that is, the right of the individual to enter and pursue any lawful trade or calling and to contract with others as employer or employe upon terms mutually acceptable as an essential part of the personal liberty of the individual.

3. While either employers or workers in the furtherance of legitimate self-interest have the right to combine for collective action or dealing, such combination has no right to compel others by intimidation or coercion to accept its direction or control.

4. Collective agreements between employers and employes, voluntarily entered into and not against the public interest, should be observed and performed by the parties with the same faith and credit as applies to any valid contract.

5. The power of industrial combinations, whether of employers or workers, is accompanied by corresponding responsibility. Where there is a lack of full legal responsibility on the part of such combinations for breach of agreement or violation of the rights of others, it is essential that they be held by the community to a higher degree of moral responsibility for their conduct.

6. Combinations to establish a monopoly of the product or of labor and to bar the competition or take away the opportunity of livelihood of those outside the combination are against good morals and the public interest.

7. The right of an industrial group to use its economic power for the benefit of its members is limited by its obligation to respect the rights of others. The use of the sympathetic strike or lockout or of the boycott involves an attack upon innocent third parties and the public, and is indefensible and intolerable.

8. The fact that disorder or violation of personal rights grows out of or is connected with an industrial controversy does not affect or lessen the primary duty of the public authorities to maintain law and order in the community and to afford the individual full protection for life and property.

9. The public interest requires that the highest degree of efficiency and productivity in industry consistent with the health and welfare of the workers should be maintained. There should be no intentional restriction of output by either employer or employe in order to cause an artificial scarcity of the product or of labor. In order that the worker may develop his full earning capacity and command his maximum wage, it is the duty of the management to assist him to secure employment suited to his abilities, to furnish him incentive and opportunity for improvement, to provide proper safeguards for his health and safety, and to aid him to increase the value of his productive effort.

10. The paramount interest of the public in the operation of the agencies of transportation and other branches of public utility service must be asserted and maintained against any attempt to bring about an interruption in the service of any public utility in the furtherance of any private purpose or interest.

11. Public employes should be accorded fair and generous treatment, and adequate means to protect their interests should be established; but the combination of such employes to interfere with or prevent the administration of any branch of the public service is a violation of their duty to the public and the state, and cannot be justified by any possible consideration.

The American Gear Manufacturers' Association now has ninety-two member companies, the five following companies having entered into the association since the April meeting: Machine & Stamping Co., Toronto, Canada; Detroit Bevel Gear Co., Detroit, Mich.; Whitney Mfg. Co., Hartford, Conn.; Diamond Chain & Mfg. Co., Indianapolis, Ind.; and Diamond State Fiber Co., Bridgeport, Pa.

* * *

NATIONAL RESEARCH COUNCIL

The National Research Council is a cooperative organization of the scientific men of America. Its members include not only scientific and technical men, but also business men interested in engineering and industry. It is established under the auspices of the National Academy of Sciences, and its membership is largely composed of representatives of forty or more scientific and technical societies. The council was originally organized in 1916 to coordinate the research facilities of the country for work on war problems, and following the war it was reorganized as a permanent body. Its essential purpose is the promotion of scientific research and of the application and dissemination of scientific knowledge.

The field of activity of the council includes the appointing of committees to consider specific scientific subjects or problems, the establishing of laboratories or institutes for research work, the publication of scientific papers, and the dissemination of scientific news and information through the press. The council has recently established the Research Information Service as a general clearing-house and information bureau for scientific and industrial research. Information is supplied concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc. A site for a new building in Washington, which is to serve as a home for the National Academy of Sciences and the National Research Council, has recently been obtained. The permanent secretary of the council is Vernon Kellogg, 1701 Massachusetts Ave., Washington, D. C.

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, November 15

THE unsettled industrial situation and the consequent stagnation of prospective business has led to an uncertain feeling in the machine tool trade, and a slackness is feared. While the majority of firms is at present fully employed on an accumulation of orders on hand, others are stated to be working to stock. A cancellation of orders has in some cases been experienced, and new business is not forthcoming. Thus, when the present accumulation of work is disposed of short time will become general, unless there is in the meantime a revival of trade confidence, with accompanying new contracts. For the present, as a precautionary measure, some firms, which, as mentioned, are working to stock, are adopting the expedient of short time to take effect immediately, and in a few cases employes are being discharged altogether.

In Scotland, shipyards, which usually absorb a good deal of local machine tool production, do not regard the future prospects as any inducement to installing new machinery. The position in the local yards is that although they have plenty of work on hand at the moment, no new orders are being placed owing to the high cost of production, so that when existing contracts have been completed there is not much to look forward to.

Export trade is also very quiet, and in several cases overseas buyers have cancelled their orders in view of long delivery and reservations regarding prices. On the other hand the Board of Trade returns show that exports of machine tools continue to increase both in value and tonnage. It is interesting to note that imports of machine tools into the United Kingdom continue to be more or less equal in tonnage quantity to our export trade in 1913, although, of course, the corresponding values are disproportionate. Exports are practically double imports, and exceed 2500 tons per month. At the same time the value of imports is nearly equal to that of exports.

The Olympia Exhibition

The great machine tool exhibition held during the first three weeks of September was marred as regards results by the coincidence of the threatened coal strike, and the uncertainty of the general situation. Although definite orders were few, the tone of inquiry was good and gave the promise of an influx of orders all around when a more settled state of affairs is reached.

High-speed Hydraulic Presses

Great developments have taken place in this country during the last few years in high-speed hydraulic presses for forging. Davey Bros., Ltd., Sheffield, are the pioneers in this work, and in their high-speed hydraulic presses the rapidity of movement of the steam hammer is combined with the continuous pressure effect of hydraulic power. The development and use of such presses is sure to modify largely the technique of heavy forging, since it is only reasonable to assume that greater homogeneity throughout the work is obtainable. As an indication of the speed of working, 100 strokes per minute can be made by a 500-ton forging press, and even at this speed the press head responds accurately to the control lever, both as to speed and change of direction.

Standardization

During the last few months the British Engineering Standards Association has authorized important new standards. Included in these are the British standards for milling cutters and reamers. The standards have been drawn up with the full cognizance of the trade and came into force on July 12. Owing to the large numbers of milling cutters and reamers imported into this country, it was necessary to obtain information of dimensions accepted in other countries, and these have been taken into account as far as possible.

Power Transmission by Fluid Waves

A new method of power transmission which utilizes waves produced in fluids has been developed during the last few years and is now being applied by W. H. Dorman & Co., Ltd., Stafford, for driving rock drills, riveting hammers and machines, coal-cutting machinery, ore conveyors, etc. The fluid in which the waves are produced is usually water, and is contained in a pipe connecting the apparatus generating the wave motions to the machine that applies them to work.

Although apparently similar to hydraulic transmission of power, the underlying principle of wave transmission is absolutely distinct. In hydraulics, a continuous flow of liquid or motion of a liquid column as a whole invariably occurs, whereas in wave transmission there is no direct or continuous flow, the liquid merely pulsating backward and forward. Owing to the degree of water compressibility being very small as compared with many materials in use, the idea that water was incompressible came to be accepted. However, in wave transmission, advantage is taken of the elasticity of water and other fluids to transmit energy.

The action occurring in wave transmission can be illustrated by a simple analogy: In the ordinary speaking tube, the pulsations set up in the contained air by the vibration of the speaker's vocal cords travel in the form of sound waves to the far end where their energy is utilized in reproducing the vibrations in the ear of the listener. The column of air in the tube does not flow through it, the particles merely being subjected to small movements to and fro as the sound waves pass along. Similarly, in transmitting power by means of the waves of a fluid, the pressure impulses set up by the generator travel through the column of fluid contained in the pipe connecting the generator to the machine being driven.

The generator contains one or more chambers filled with the power-transmitting fluid and connected directly to the wave-transmitting pipes. A plunger is reciprocated into each of the chambers by means of a crankshaft driven by a motor or belt. As these plungers are reciprocated, the water in the chambers and connecting pipes is pulsated to and fro, the waves traveling at the rate of approximately 4800 feet per second, and causing plungers on the machines being driven to have similar movements. Thus, reciprocating movements are, of course, essential in the types of machines mentioned. When it is desired to rotate the tool, as in the case of rock drills, for instance, energy derived from the waves may also be employed for this purpose.

The fluid used in this system of transmission may be fed into the generator and pipe by means of gravity, but when this is impossible or undesirable, a simple pump is fitted to the generator. The feed of the fluid into the generator is regulated by a valve actuated by the pressures in the fluid chambers. A special type of flexible piping having ball and socket joints is used between the generator and the machine being driven, it being claimed that this piping is absolutely leakproof and has no tendency to stretch or straighten when submitted to high internal pressures.

Machining Cream Separator Bowls

Methods Employed by the De Laval Separator Co., Poughkeepsie, N.Y.—First of Two Articles

By FRED R. DANIELS

THE cream separator bowl which houses the mechanism by means of which cream is separated from milk consists of two main parts, the bowl shell shown at *A*, Fig. 1, and a tubular shaft *B* which forms the bottom of the shell of the bowl and provides a passageway through which the milk flows into the bowl. In order to make the various machining operations more easily understood, a brief description of the principles upon which the separating mechanism operates is given.

Within the housing formed by the shell and the tubular shaft, a series of tin cones is arranged, the cone angle coinciding with the 40-degree angle on the lower end of the tubular shaft, so that a seat is provided for this stack of tin cones. The arrangement may be clearly seen in Fig. 2 which shows a section of the assembled bowl, and the arrangement of the stack of cones. The top cone *K* is different from the others in the series in that it is provided with an extension in the form of a neck which will be apparent from the illustration. This neck contains the cream outlet *B*, located near the top. A steel part known as a distributor, shown at the left in this illustration, fits over the tubular shaft and seats on surface *C*, Fig. 1, of this forging. The position of this distributor, with reference to three tangential slots *U* in the tubular shaft, is such as to align the slots with passages on the inside of the distributor. The remaining cones of the set have their central hole stamped out to fit over the outside of the distributor.

This entire unit, when in operation, revolves at a velocity of from 6000 to 9000 revolutions per minute, depending upon the size of the separator, and is driven by a vertical spindle which extends up into a bronze bearing in the tubular shaft and engages a driving dog, which is a press fit in the tubular shaft. The location of this dog is such as to form a bottom for the chamber in the tubular shaft, slightly higher than the lower end of the three slots in the shaft. The relation of the driving dog to the slot may be seen in Fig. 10. Thus it will be understood that by delivering the milk into the hollow shaft, with the machine rotating at this high velocity, the milk will be forced out of the three tangential slots in the tubular shaft and into the passageway in the distributor, from which it will be delivered through the hole *H*, Fig. 2, into contact with the cones where the process of separation takes place. Each cone has three holes so located that when assembled over the distributor they will align with each other and with the delivery hole *H* in that member. Referring again to the assembly view, it will be seen that a space is provided between each of the cones sufficient to allow the passage of milk as it is forced from the distributor through the aligning holes of the cones. The principle of operation of the separating mechanism will be understood from the following description.

Principle of Operation

The operation of the cream separator is based on the principle of centrifugal force, the heavier material—skimmed milk—being precipitated against the walls of the shell, and the lighter material—the cream—working its way up on the upper side of each cone. After a sufficient amount of cream has accumulated, the continuous supply of milk being delivered to the machines will cause the cream to pass upward through the passageways on the outside of the distributor shown at *G*, Fig. 2. This cream fills the spaces between the neck of the top cone and the tubular shaft, whence it is delivered through the outlet in the top cone, which is located in a projection that fits in slot *S* of the bowl (see Fig. 1). The skimmed milk at the same time is being delivered through outlets *T* from the space between the outside of the top cone and the inside of the shell. In following out the various machining operations on these two parts, the purpose of such details as the tangential slots in the tubular shafts and the slot in the neck of the bowl through which cream is delivered will now be understood.

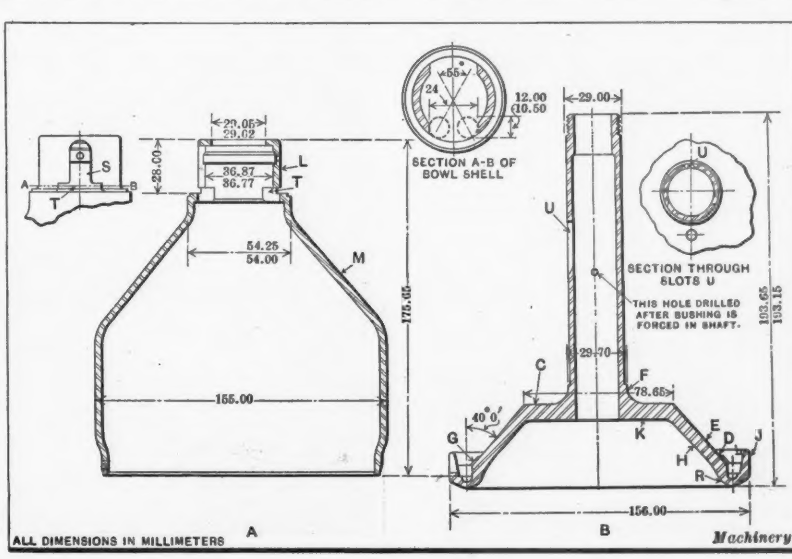


Fig. 1. Sectional Views of the Bowl Shell and Tubular Shaft of a Cream Separator

Forging and Roughing Operations on the Tubular Shaft

The tubular shaft is forged from mild steel bar stock, 2½ inches in diameter, from which it is sheared to the approximate length in a Covington shear. After heating in an oil-burning furnace, one end of the sheared bar is reduced in diameter in a Bradley helve hammer. The general appearance of the work after this operation is indicated at *A*, Fig. 3. This illustration is a view looking into the end

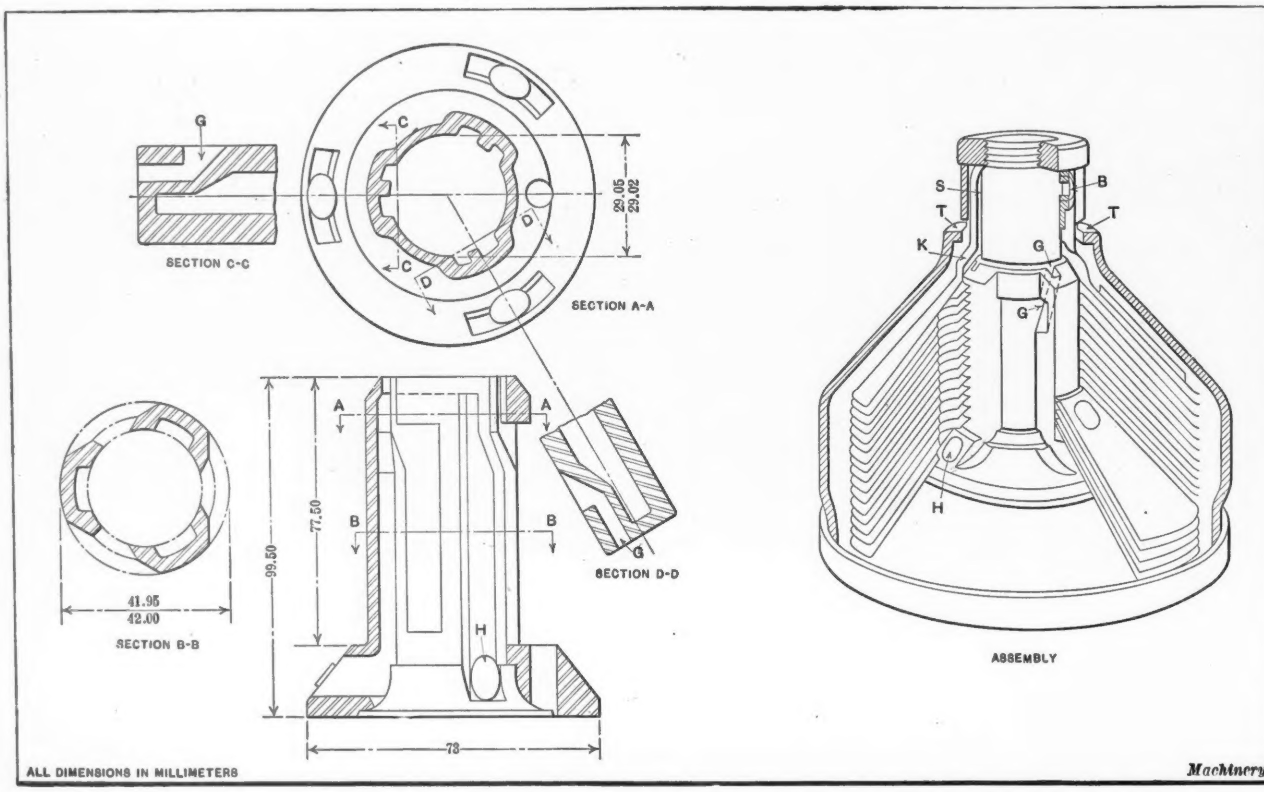


Fig. 2. Sectional View of the Cream Distributor and a Sectional View of the Assembled Bowl Unit showing the Relation of Cones to the Passages in the Distributor

of an Acme bolt-header, and shows the forging tools quite plainly. The die employed is of duplex construction, two operations being necessary to upset the end of the hot bar and forge the large end to the shape shown at *B*.

Before describing the machining operations on this forging, it should be stated that at the De Laval plant all work is performed to the metric system of measurement, so that it will be understood that what few dimensions appear on the drawings are given in millimeters and not in inches. The first operation in the machine shop is performed on a Jones & Lamson flat turret lathe and is illustrated in Fig. 4. This operation consists of roughing out the under surfaces of the forging, using in the first station a heavy two-bladed boring head which can just be seen at *A*, to hog out the angular surface; in the second station, a center drill; in the third and fourth stations, drills for drilling the small and large diameters of the hole in the tubular shaft (see Fig. 1). The hole is then rough-reamed with the floating reamer *B* carried in the fifth station on the turret, and the final work performed on this machine consists of beveling the inner and outer edges of the base, using a tool-holder which carries both tools necessary for the performance of this operation. This tool-holder is located on the opposite side of the turret, and consequently the position of the tools cannot be seen. The time required to perform this first roughing-out operation is nine minutes.

Reaming Large Hole in Tubular Shaft and Machining Slot in Periphery

The large hole is next finish-reamed on a small bench machine, after which a Whitney hand milling machine is employed to machine a slot in the periphery of the work. The sole purpose of this slot is to provide a means of driving the forging in the subsequent machining operations. In the fourth operation, use is made of this driving dog slot in connection with a pilot center in the machine spindle, to locate the work in the chuck of a Brown & Sharpe hand screw machine. This operation consists of facing and countersinking the top of the shaft and reaming the small hole.

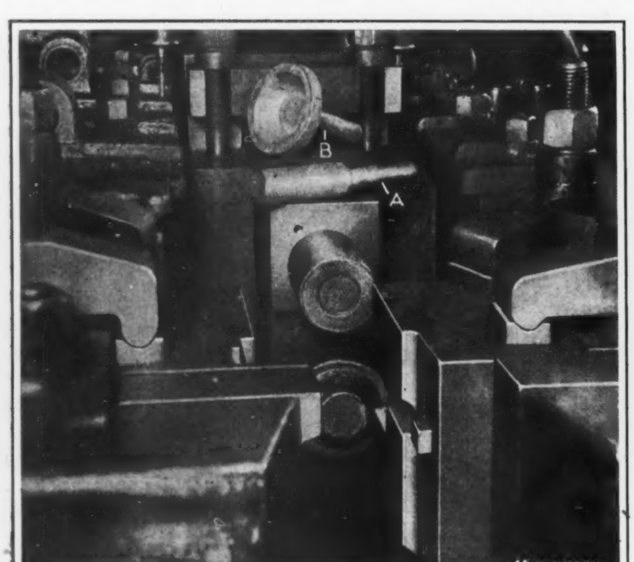


Fig. 3. Tubular Shafts forged to Shape in Two Operations on a Bolt-header

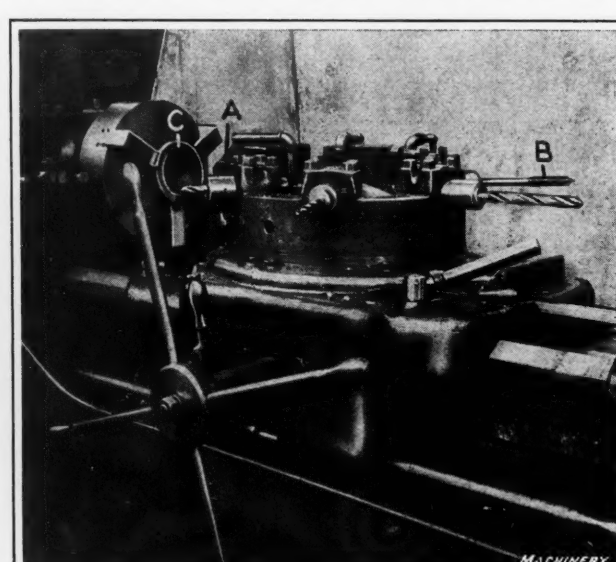


Fig. 4. Flat Turret Lathe equipped for roughing out the Bottom of the Forging

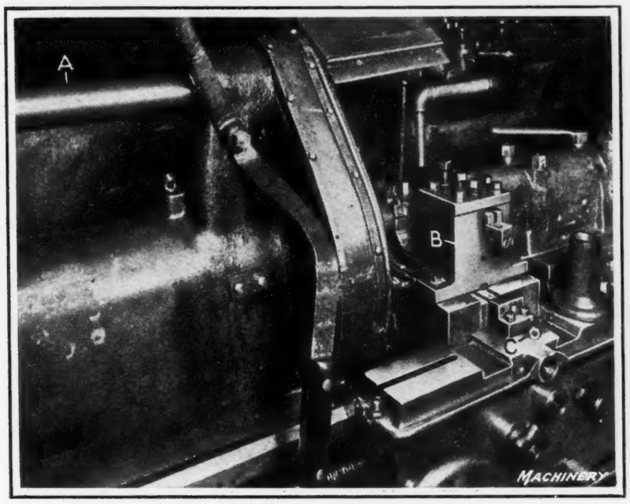


Fig. 5. Lathe equipped with Special Direct Drive Heavily Constructed Head for Use in rough-forming the Surfaces which furnish the Seat for the Bowl Shell

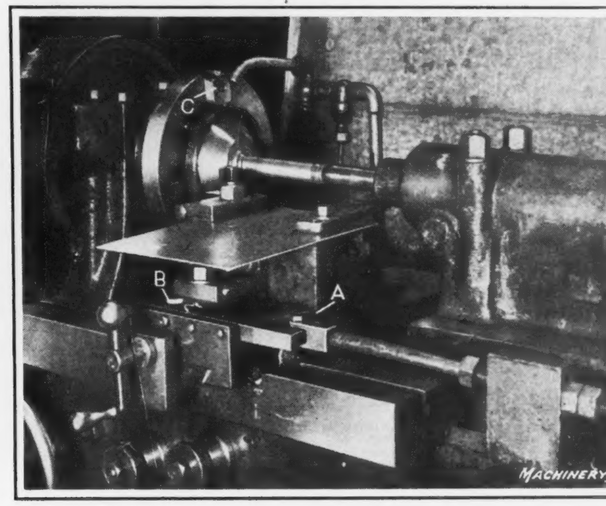


Fig. 6. Geared-head Lathe equipped for rough-turning Angular Surface of Forging. In this Operation a Special Taper-turning Attachment is employed

The production rate is sixty-six pieces per hour. In the fifth operation, the bottom surface *C*, Fig. 4, is ground to form a bearing for subsequent operations, the work being held to within a limit of 0.05 millimeter, or about 0.002 inch. The work is performed on a Brown & Sharpe disk grinder; it is held between centers, a center bushing being used in the top end of the shaft for the tailstock center, and the dog slot on the opposite end. The production time for this operation is fifty five pieces per hour.

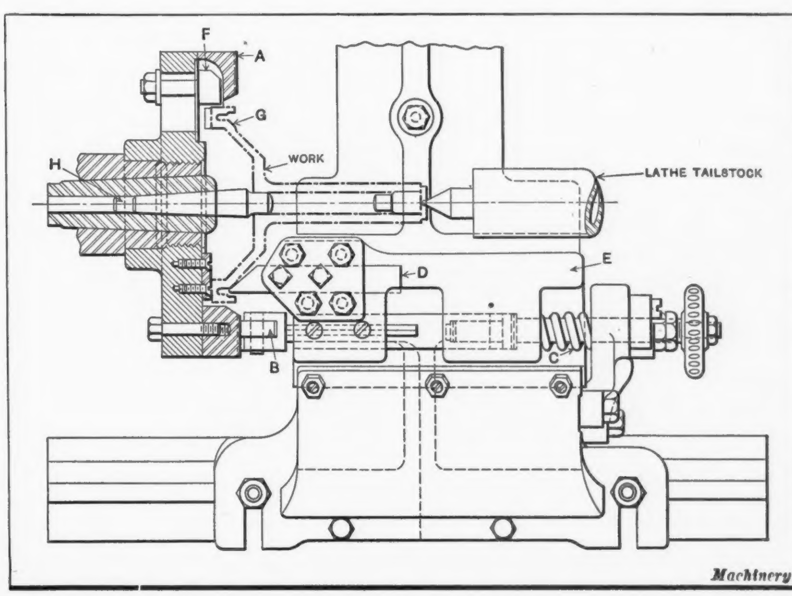


Fig. 7. Assembly View of the Special Attachment employed in turning Calks on Forgings

In the sixth operation, which consists of rough-turning surfaces *D*, Fig. 1, difficulty was experienced at first in obtaining equipment which was rugged enough to take the heavy cut required. The equipment for this work now consists of a Lodge & Shipley 20-inch lathe having a special direct gear drive to the faceplate, operated by a Johnson clutch and carried in a ruggedly constructed special headstock. This machine is illustrated in Fig. 5, and although the driving end of the machine is not shown, it will be evident that the power is transmitted to the faceplate pinion carried on the driving shaft *A*, for the purpose of driving the faceplate. A proportionately heavy toolpost *B* is used, in which the tool is adjustably mounted. In this operation a plug center *C* and the previously machined dog slot are used to mount the work in the machine. A production of seventy-eight pieces per hour is obtained.

After being rough-turned on a 16-inch Prentice geared-head lathe, the shafts are next ready to be rough-turned on the angular surface *E*, Fig. 1. This operation is performed on a Lodge & Shipley lathe equipped with a special taper-turning attachment. The cam-slide of this device is operated by the cross-slide screw, and is attached to the lathe saddle so that the tool may be adjusted to agree

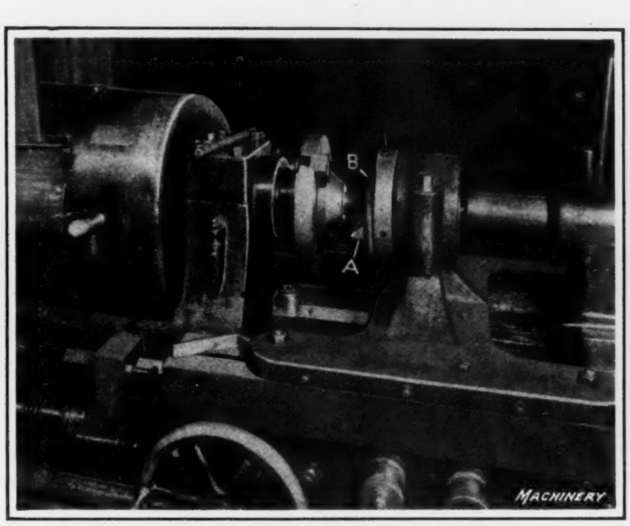


Fig. 8. Lathe equipped for finish-turning the Surfaces machined in the Lathe shown in Fig. 5

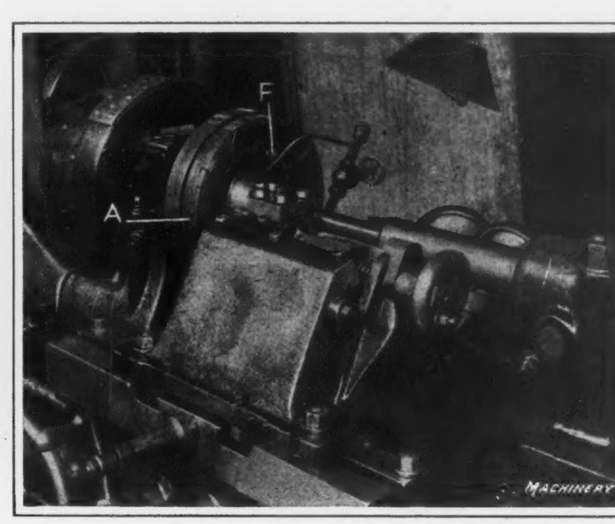


Fig. 9. Lathe employed in turning Calks on Outer Angular Surface of Forgings with Special Attachment

with the diameter of the work to be turned and traversed by means of the regular feed-screw. The set-up is illustrated in Fig. 6, which clearly shows the cam-slide *A* and the slot *B* in which the roller operates to feed the tool in an angular direction. This illustration also shows the use of the faceplate dog *C* which engages the dog slot on the outside of the work. Production time on this job is forty-five shafts per hour.

Finishing Operations on the Tubular Shaft

In the ninth operation, which is the first finishing operation on the forging, a 20-inch geared-head Lodge & Shipley lathe is used, which is illustrated in Fig. 8. This operation consists of finish-turning the surfaces *D*, Fig. 1, employing a special formed tool which may be seen at *A* in Fig. 8. An oil-tube *B*, formed to the shape of a ring and perforated with holes, is used to deliver the lubricant into the inaccessible surfaces which are finished in this operation. The production time is twelve tubular shafts per hour. The next two operations consist of finish-turning the radius *F*, Fig. 1, at the bottom of the shaft, and facing and forming the radius at the top end of the shaft. In the latter operation a Pratt & Whitney No. 2½ hand screw machine is used, the work being produced at the rate of 104 pieces per hour. The twelfth operation consists of grinding the thread end of the shaft 0.01 millimeter smaller than the main diameter. This operation is performed on a Brown & Sharpe No. 11 plain grinder, at the rate of seventy pieces per hour.

Turning Calks on Angular Surface of Forgings

One of the most interesting operations on the tubular shaft is known as the "calking" job. These calks, of which there are six equally spaced on the angular surface of the shaft, are indicated at *G*, Figs. 1 and 11, and the operation of relieving the space between these is performed on a Lodge & Shipley lathe especially equipped for this purpose.

Fig. 10. Testing Concentricity of the End of the Shaft

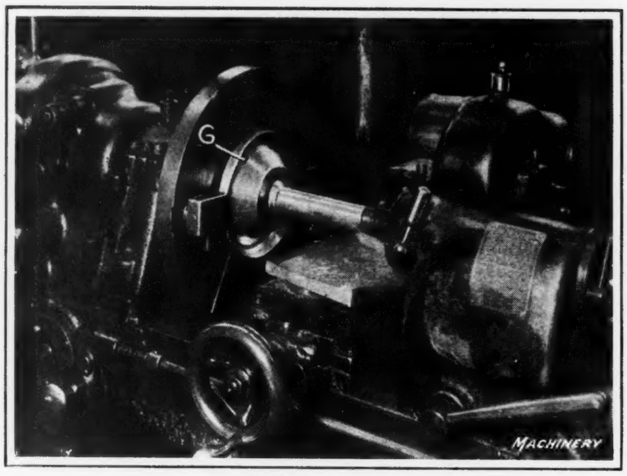


Fig. 11. Thread Milling Machine employed in milling the Thread on the End of the Shaft

This operation is illustrated in Fig. 9, and the special equipment employed in connection with the lathe is shown in detail in Fig. 7, from which it will be apparent that a special cam-ring *A* is fastened to the faceplate, this cam-ring containing six raised portions or lugs, located radially, against which roller *B* operates. The tension of the coil spring *C* may be regulated as desired by means of the handwheel carried at the end of the roller shaft. The tool-holder which carries the tool *D* is attached to slide *E*; thus as the roller rises and falls over the lugs on the cam-ring, the tool is intermittently lifted from the surface which it is engaged in turning, so that at the completion of the cut the calks are formed on this angular surface.

The entire attachment is secured to the lathe carriage, and the work is located by means of the dog slot in which driving dog *F* (see also Fig. 9) engages, and is supported at the outer end by the tailstock center and a center plug, as shown in Fig. 7. The use of a pilot center *H* in the lathe spindle assures that these calks will be located concentrically with the center line of the tube shaft. In the description of the construction of the cream separator, it will be remembered that spacing pieces are employed to separate the several cones from each other so as to provide space through which the milk is forced. The purpose of the calks on the tubular shaft is to provide a similar space between it and the lowest cone. The rate of production on this job is forty-seven pieces per hour.

Milling, Slotting, Forming, Turning and Grinding Operations on Tubular Shaft

The four following operations on the tube shaft, 14 to 17 inclusive, consist of two milling operations on a Whitney hand-operated machine to produce the tangential and radial sides of the three milk slots; and two die slotting operations to square the curved surfaces of these slots. The die slotting operations are performed on a Garvin die slotter equipped with an indexing head for rotating the work to bring each slot in the proper relation with the tool.

In the eighteenth operation, a forming tool is used to finish the angular surface *H*, Fig. 1, and the radius *R* at the bottom of the forging; this tool also forms the radius at the intersection of surfaces *H* and *K*. A second tool is provided for finishing the remainder of surface *K*. This work is performed on a Jones & Lamson flat turret lathe at the rate of thirty-one pieces per hour. The nineteenth operation consists of milling a pin slot (the location of which may be seen at *A*, Fig. 10) which is used to locate the bowl within the flange of the shaft by means of a correspondingly located pin on the bowl. The work is performed on a Whitney hand miller, being held in a clamp on the table of the machine in which it is located by the dog slot. This is the last function of the dog slot in the machining of the bowl, for in the following operation the outside diameter of the rim is rough-turned, thereby removing the driving dog slot. This

operation is performed on a Prentice 16-inch geared-head lathe; in this case, the work is driven from the recently machined pin slot, and is located from the surfaces *D*, Fig. 1, in which suitable clamps engage, which are operated by an air-operated draw-in chuck. The production time on this operation is eighty-three pieces per hour. The work is next recentered, and the rim *J* is ground on a No. 11 Brown & Sharpe plain grinding machine. In the twenty-third and twenty-fourth operations the shaft is rough- and finish-ground, the finished surface being held to within limits of 0.02 millimeter. These operations are performed on a Brown & Sharpe grinder at the rate of about 100 per hour.

The twenty-fifth operation is that of drilling the hole for locating pin *B*, Fig. 10. The purpose of this pin is to position the distributor accurately in relation to the slots in the shaft. The hole is accurately located by means of a jig which fits over the spindle and which has a single tooth that engages the pin slot. After a series of bench operations has been performed on the parts, they are sent to the tinning department, and after being tinned, the bronze bearing bushing for the driving spindle is assembled in the shaft.

The final operations on the work are not unusual (although of considerable importance to the operation of the separator) and need not be enumerated. Fig. 11 shows the last operation prior to the final inspection of the shafts, in which a Pratt & Whitney thread milling machine is shown set up for milling the threads on the end of the shaft. This illustration shows the method of locating the work on the faceplate by means of a driving dog engaging the pin slot. The production time on the thread-milling operation is twenty-four pieces per hour. Fig. 10 shows the apparatus employed to inspect the running truth of the end of the tubular shaft by means of an Ames indicator, the work being mounted on a spindle which engages the driving dog *C* within the spindle. This arrangement is identical with the construction of the cream separator.

* * *

PROPERTIES OF DURALUMIN

In an article recently published in *Technische Berichte*, the physical properties of duralumin, which is used in the construction of aircraft, are dealt with. This alloy is made in various compositions, the amount of the different elements contained varying between the following percentages: Aluminum, 95.5 to 93.2 per cent; magnesium, 0.5 per cent; copper, 3.5 to 5.5 per cent; and manganese, 0.5 to 0.8 per per cent. Lead, tin, and zinc have an unfavorable influence upon the permanence of aluminum alloys, and so are not found in duralumin. The specific gravity of the latter varies from 2.75 to 2.84, according to the composition and hardness. The melting point is about 1202 degrees F. Duralumin has a strength of from 50,000 to 57,000 pounds per square inch and an elongation of 10 to 15 per cent in two inches. The modulus of elasticity is from 8,500,000 to 10,000,000 pounds per square inch. It is very brittle, especially in thicknesses above 0.04 inch, and consequently is sensitive to alternate bendings to and fro.

Working the Alloy

Duralumin can be rolled into plates and shapes, the elongation decreasing as the hardness of rolling increases. Tube blanks, however, can be made only by pressing and not by the oblique rolling method. The alloy can be tempered by heating and sudden cooling. For this purpose, plates, tubes, and shapes are heated to between 896 and 950 degrees F., quenched, and then aged. The original strength is very nearly restored after the quenching, but the tensile strength continues to grow with the ageing from 50,000 to 70,000 pounds per square inch. The elongation does not decrease, but remains at least the same and usually increases slightly. In practice, the greatest strength is reached after about five days of ageing. When heated to over 986 degrees F., duralumin becomes unusable; consequently the treating is carried on in a bath of nitrates, the temperature of which can be carefully regulated and watched. During the ageing of the metal, work should not be done on it which would change the section, as in that case the strength would not increase further. After the completion of ageing, the material can be rerolled to obtain smooth surfaces. Because the material may warp in tempering, it is not good practice to temper riveted parts; such parts should be tempered before they are riveted.

Modulus of Elasticity and Ductility

Duralumin is made in various compositions having different properties to suit the purpose for which it is intended. The modulus of elasticity of a hard composition known as "681a" was found to be 10,000,000 pounds per square inch. Making allowances for the possible effect of vibration on the modulus of elasticity, it appears better to use not more than 9,250,000 pounds per square inch in computations. In judging the suitability of a material for use in stressed parts, not only the tensile strength but also the ductility is of great importance. This can be determined by bending strips backward and forward through 180 degrees over a definite radius, usually 0.20 to 0.40 inch, the number of bends possible before a fracture being taken as a measure. Although the strength values of steel plates used in several experiments were less than those of the duralumin plates, the steel plates could be bent much oftener, since they possessed greater ductility. The number of bends for both metals decreased with increased thicknesses. The difference was least for plates under 0.02 inch in thickness. For thicker plates of duralumin, the number of bends decreased very rapidly; a plate 0.08 inch thick broke over a 90-degree bend, and a plate 0.16 inch thick broke over a 45-degree bend. This property makes duralumin unsuitable for highly stressed parts which must also withstand vibrations.

Influence of Heat and Cold on Duralumin

Heat has an important influence on the strength of duralumin, the results of tests indicating that the strength decreases 10 per cent for an increase in temperature of 212 degrees F. and about 20 per cent for an increase of 302 degrees F. The loss in strength increases with the increase of temperature. On first heating the increase in elongation is hardly appreciable, and between 302 and 392 degrees F., it decreases. At 482 degrees F., the elongation becomes the same as at the room temperature. Upon further heating the elongation increases with a rising temperature. Consequently, wherever duralumin is exposed to heat, the possible decrease of strength must always be considered. Opposed to this, the influence of cooling on the strength properties is less unfavorable. The strength and elongation increase somewhat with a decrease in temperature.

Experiments on the influence of weathering on the strength of duralumin, which have been carried on by the Durener-Metallwerke for three years, have shown that there is no observable decrease in the strength. Experiments have also been made to determine the electrolytic effect from junctions of duralumin with iron or steel. These were made by riveting duralumin bars to iron plates and then placing them in artificial sea-water. The result was only an insignificant destruction of the iron and a reduction in the weight of the bars of about 0.23 per cent, so there is no objection to using duralumin and iron junctions in aircraft.

* * *

According to W. B. Colver of the Federal Trade Commission, in charge of operation of the Webb-Pomerene law, forty-four associations comprising about 1000 concerns located in forty-three states have been formed in the two years' operation of the law. During this period not a single complaint has been made by a foreign customer against any of the associations.

Service Factor in Interchangeable Manufacturing

Importance of Considering, during the Development, Designing and Manufacturing Periods, the Service which a Machine or Device Must Render

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

THE ultimate test of any manufactured article is the test of service. The component parts may be absolutely interchangeable, the manufacturing processes may be developed to produce large quantities economically, and the inspection may be as rigid as possible; yet if the required service is not rendered, all of this work is useless.

Consideration of Service in Preparing Functional and Manufacturing Designs

If a commodity is to give satisfaction, this service must be built into it at every stage of its development and manufacture. The first conception of a new mechanism develops from the realization of some service to be performed. The functional design of this mechanism is solely the development of some mechanical means of performing this service; this thought is paramount and every other consideration is subordinate to it. It is only after this result has been obtained that any great thought is given to the matter of producing the mechanism commercially.

The primary purpose of the manufacturing design is to develop the functional design into one which can be economically manufactured; yet, at the same time, the greatest care must be exercised to maintain all the serviceable qualities of the original design. The factor of economical manufacture must never be the controlling one when economy is secured at the expense of service rendered. The customer is purchasing this service, and any action which may rob him of some part of it, is unjustifiable. The development of the correct manufacturing design is a long process. There are no laboratory tests which will show all the requirements and results of service. The largest part of this information must necessarily come from the study of the results obtained from the commodity when in actual service.

In the final analysis, no manufactured machine or device is ever purchased for itself alone, but is acquired for the purpose of securing the service which it is supposed to render. Thus, for example, the purchase of a reamer is the purchase of reamed holes of a desired quality or standard. Consequently it follows that the reamer which produces the most reamed holes of the required accuracy at the least ultimate cost is the best reamer and is finally recognized as such. Its first cost may be higher than others, yet if it produces more holes during its life, or produces them more quickly or with less power, the average cost of the reamed holes may be much less than those produced with a cheaper tool. In like manner, the purchase of a machine tool represents the purchase of machined surfaces; the purchase of a typewriter, typed letters; the purchase of a sewing machine, sewn seams; of an automobile, transportation, etc.

A large amount of this information can be readily secured if proper attention is given to every complaint from customers. Too often, information from such sources is treated as an annoyance to be smoothed over rather than as a definite problem to be solved or as a matter which is of far more value and importance to the producer than to the customer. In general, a complaint from a customer results from one of three causes: First, some faults in design, workmanship, or material may exist in the mechanism which prevent it from giving the service which is due the customer. If this is the case, prompt steps should be taken to correct the trouble at its source. Obviously this matter is of more importance to the producer than to the user if he hopes to remain long in business. Second, the customer may not thoroughly understand the handling and care which the mechanism requires. In such cases it is of the greatest importance to the manufacturer that the customer obtains the needed information, or else the reputation of his product will inevitably suffer.

The third complaint is usually due to the customer's attempt to perform work for which the product was not intended or which is beyond its capacity. It is essential that the manufacturer know the limitations of his product. Furthermore, information derived from complaints of this sort often lead to modifications of the product which greatly increase its field of usefulness. Complaints of all sorts should be carefully checked and acted on accordingly. Several manufacturing concerns have a man or division in their engineering department that investigates all complaints from customers, using the information so gained in the improvement of their product. Only by such knowledge of actual results obtained under many conditions can the maximum service be built into a product.

Keeping Specifications up to Date

The specifications should include all information which is needed to produce a commodity capable of giving the desired service. In whatever form they are kept, they should be constantly revised to keep abreast of the needs of service. For example, if the material specified for a certain part proves too weak in actual use, it must be altered. Thus, the part may require a stronger material, a different kind of heat-treatment, or a strengthened design. Often it may be found that the original requirements of many surfaces or parts are not the correct ones. All of this information, if kept in such form that it is always available, will be found invaluable in the development of future products; products which will contain from the start a higher quality of service than any of the preceding ones.

Planning Production to Obtain Requisite Service

Every part of the manufacturing equipment provided should be selected or designed with the object of producing parts capable of rendering the required service. The design of the commodity itself, if properly recorded on the drawings, will emphasize these points; yet a careful check should be made to insure that no vital factor has been overlooked.

The constant care which must be exercised in every stage of the actual production determines in a large measure the character of the service delivered. No operation is too unimportant to be neglected. This care, however, must be taken by each individual workman. To obtain the necessary cooperation, every effort must constantly be made to develop

in each workman the spirit of true craftsmanship. A craftsman, in the opinion of the writer, is a man who takes pride in the work and skill of his hands and brain; who feels that each result of his labor is a monument to himself; and whose enthusiasm and consciousness of power prevent him from doing any work but his very best. No man can do justice to his own capabilities unless he is interested in and proud of the results of his labor. The manufacturer must realize that he should have a vital interest in the proper training of each one of his workmen, and should use every means in his power to foster true craftsmanship in all branches of his establishment. No part of any work is too elementary to justify such an attitude.

Inspecting Parts to Insure Service

Every inspector must keep in mind at all times the requirements of service which the parts under inspection must render. This service is the sole purpose for which the parts are made. If they will render it, the parts are correct; if not, they are incorrect. In a well-balanced organization, the inspection is not carried on to discover the faults which others have committed, but rather to protect the customer and the firm's good name as well, by guarding against the possibility of faulty work going out despite all precautions taken in the productive departments. Yet, even with the most rigid inspection, some flaws remain hidden and are not discovered until the commodity is in the hands of the customer. With an honest inspection, such occurrences will be the exception, but without proper safeguards, these occurrences are apt to be the rule, and the customer will soon learn it, to the disadvantage of the manufacturer.

The majority of mechanical products are tested on work of the type they are built to perform before they are shipped. Needless to say, no attempt should be made to favor the commodity in such tests. Every effort should be made to detect any faults, and each fault detected should be permanently corrected. The interest of the manufacturer in the commodity should not cease when it reaches the customer. It is of more interest to the manufacturer than to the purchaser to see that his product is employed on the work it can best perform, and to see that it performs its maximum service. By so following up his product, he not only makes a satisfied customer but also creates new markets for his product. Furthermore, as noted previously, the information gained by observing his mechanisms in service under many varying conditions, will be invaluable to him in developing and improving his product, as well as often pointing the way to the development of new products.

Manufacturers in a number of different lines have established well-organized service departments with a view to insuring that the machines or devices that they build will give the highest possible service and satisfaction to their customers. Such service departments are well known in the automobile and typewriter fields, but similar departments, somewhat different in their nature, on account of the varying conditions under which the product is used, are also found in the machine tool field, where some manufacturers have highly organized service departments for determining the best conditions under which the customer's work may be performed. Through such service departments it has often been found possible to increase greatly the output of the machines built.

COMPLETION OF THE SERIES ON INTERCHANGEABLE MANUFACTURE

The article beginning on the preceding page is the last one in the series of articles dealing with the principles of interchangeable manufacture that began in the July, 1919, number of MACHINERY, and of which one article has appeared each month until it is now completed with the present article "Service Factor in Interchangeable Manufacturing."

In this series, the author, Major Earle Buckingham, has discussed the various phases involved in interchangeable manufacturing practice. The first article dealt with the principles of the subject, followed by articles on the "Terms Used in Interchangeable Manufacturing"; "Machine Design in Interchangeable Manufacturing Practice"; "Purpose of Models"; "Practice in Making Component Drawings"; "Economical Procedure in Interchangeable Manufacturing Practice"; "Equipment Required and Gages of Different Types Employed"; "Inspection and Testing in Interchangeable Manufacture"; "Manufacturing for Selective Assembly"; and "Small-quantity Production Methods."

MAJOR EARLE BUCKINGHAM

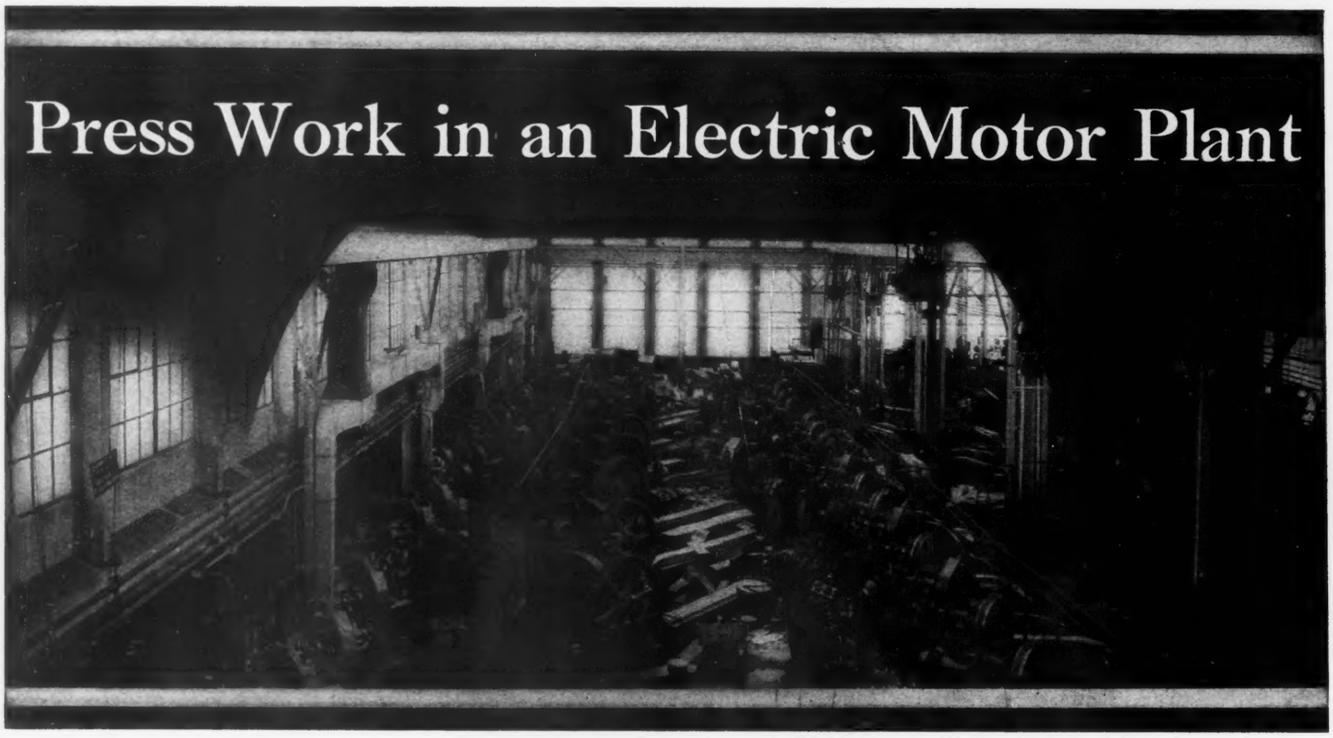
Author of the Series of Articles on Interchangeable Manufacture Concluded in the Present Number

It is the first time in technical literature that this subject has been dealt with as completely as it has been by Mr. Buckingham. His unusual training and experience make him particularly qualified to write such a series of articles; since his education at the United States Naval Academy at Annapolis, he spent fourteen years with various manufacturing concerns engaged in interchangeable manufacturing on a large scale. Among these firms may be mentioned the American Graphophone Co., Bridgeport, Conn.; the Winchester Repeating Arms Co., New Haven, Conn.; the Veeder Mfg. Co.; the Royal Typewriter Co., and the Pratt & Whitney Co., Hartford, Conn.; and in addition, his experience has covered munitions work with the Canadian Car & Foundry Co., and the Eddystone Munitions Co. In July, 1917, Mr. Buckingham took charge of the gage section of the inspection division of the Ordnance Department, being commissioned as captain. He was later transferred to the engineering division, where he was engaged both in the cannon section and the gage section. In October, 1918, he was promoted to major, and after his discharge from the service in January, 1919, came to the Pratt & Whitney Co., where he has had ample opportunity to make use of his varied experience in interchangeable manufacturing methods.

Mr. Buckingham is an associate member of the American Society of Mechanical Engineers, and a member of the Society of Automotive Engineers. He served as a representative of the latter society on the visit which the National Screw Thread Commission paid last summer to England and France in order to confer with the leaders in engineering there on the subject of standardization of screw threads. He is also a representative of the American Society of Mechanical Engineers on the Sectional Committee on Plain Limit Gages of the American Engineering Standards Committee, and a representative of the Society of Automotive Engineers on the Sectional Committee on Screw Threads of the American Engineering Standards Committee.

It is planned to make Major Buckingham's treatise on interchangeable manufacture available in book form within the near future, as doubtless mechanical men engaged in interchangeable manufacturing will want to be able to use this treatise for permanent reference.

Press Work in an Electric Motor Plant



Second of Two Articles Describing Methods Used in the Power Press Department of the General Electric Co., Lynn, Mass.

IN the preceding installment of this article, published in the November number of MACHINERY, a description was given of the design and operation of various compound blanking and perforating dies of the sub-press type. The present, and concluding, installment describes the power press equipment used in the production of street railway motor gear-cases; two types of dies used in making turbine-motor stampings; an automatic feeding mechanism and stop for power presses; and the indexing mechanism and work-holding devices used on notching presses when producing electric motor stampings.

Manufacturing Gear-cases for Railway Motors

The making of gear-cases for electric railway motors involves a special drawing operation which is performed on a Ferracute double-action press. The stock from which these gear-cases is made is 9/64 inch thick, and the shells are drawn to a depth of 10 inches, the width and length being 4½ and 23 inches, respectively. The shell before and after being trimmed is shown in Fig. 16, and a plan view of the assembled gear-case is shown in Fig. 17. The blanks from which the shells are made are first roughly sheared to the desired polygonal shape, after which they are drawn in one operation.

The operation of trimming the sides is shown in Fig. 18. The shells are laid flat on the side and slid under the shearing punch which is provided with a spring-actuated guide plate for the shear blade. The upper and lower members of the shear are held in alignment by means of square pillars, similar to the construction of sub-presses. A suitable stop and hand-operated eccentric are used to locate the work properly and to hold it in the desired position. The eccentric handle may be seen in the illustration. After the two sides have been trimmed parallel, they are taken to the press shown in Fig. 19, where the ends of the shell are trimmed. This machine is built by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., and is equipped with a special swiveling fixture for securing the work during the operation. This fixture holds the work in a vertical position during the trimming process, the shells being strapped in a suitable cradle.

When loading the shells, the fixture is swung to the left and swiveled so as to bring the shells into a horizontal position for convenience in loading. The fixture is then swung into the vertical position and locked in line with the shear by means of pin *A*, after which the work is advanced under the blade by an operating lever *B*. The stanchion of the fixture rides in a slide in the cast-iron support *C*, so that as the operating lever is manipulated, the sliding stanchion is brought up against stop *D*, thus enabling the ends to be trimmed in the same plane as the trimmed slides. A handle *E* located at the top of the fixture serves to raise the work by means of an eccentric, sufficiently to obtain the proper vertical relationship between the end of the shell and the shear blade. The opposite end of the work is brought into position to be trimmed, by simply sliding the fixture away from the machine, swiveling the cradle 180 degrees, and returning the sliding stanchion to the stop.

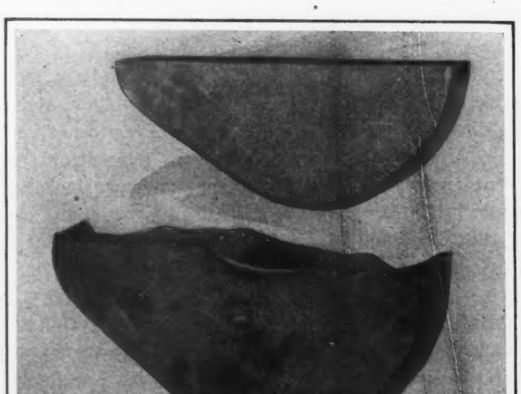


Fig. 16. Steel Shell (before and after trimming) from which the Gear Guard shown in Fig. 17 is made

After the holes for the axle and motor pinion-shaft and the oil-hole in the top half of the gear-case have been punched out, a flange *A*, Fig. 17, is spot-welded to each half of the gear-case. In manufacturing this flange, the blank is trimmed on the corners to the desired shape, and a central strip is cut out on a combination blanking and piercing die, as indicated at *B*. The stock is also cut out at *C* and bent at right angles as indicated by the dotted line. By bending the stock in this manner, the ends assume a U-shape, and the stock between the

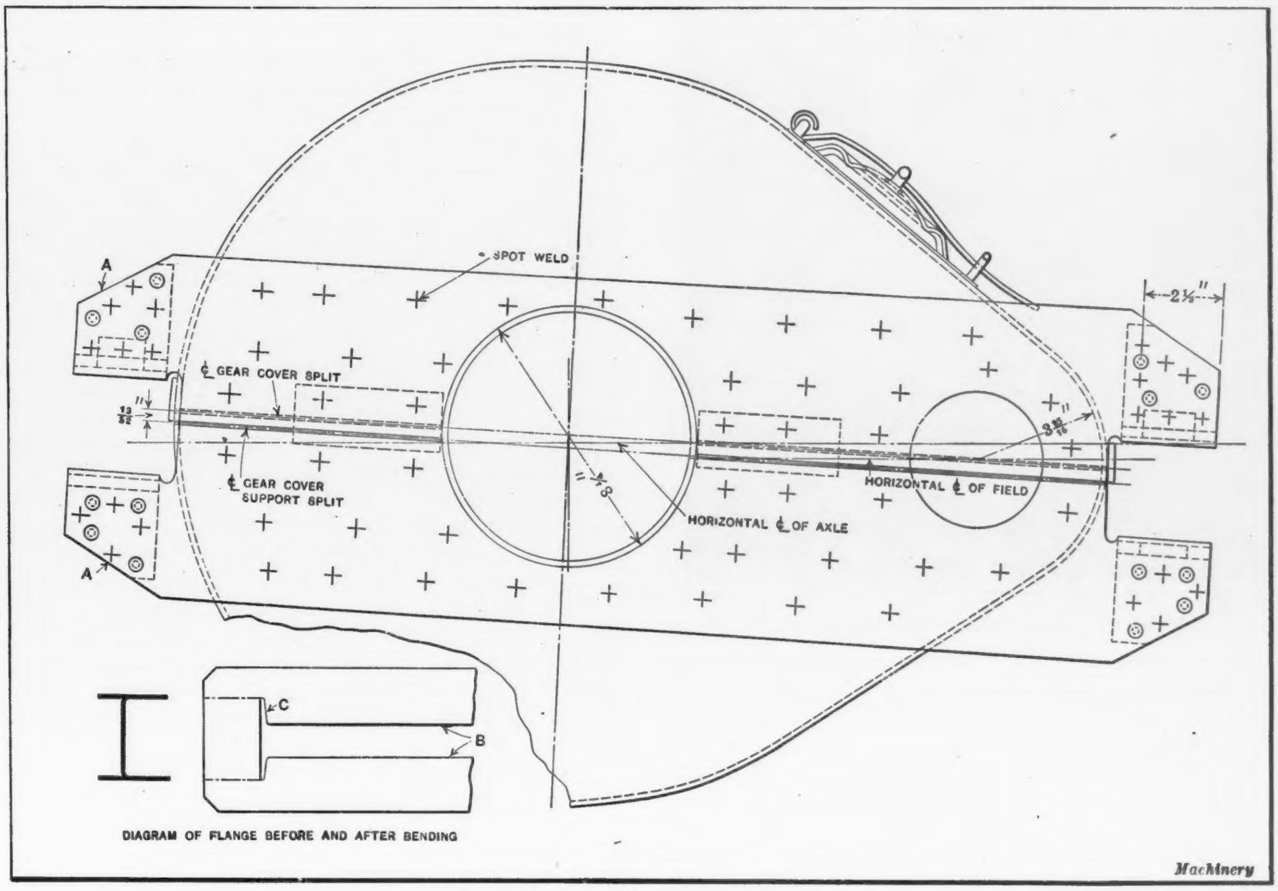


Fig. 17. Sheet-steel Gear Cover for Electric Railway Motors, and Development of the Flange before forming

ends forms the flat flanges on each side of the shell. This shape is indicated in the diagram.

Methods and Equipment Used in Producing Turbine-motor Stampings

There are two types of machines and two kinds of equipment employed in the General Electric Co.'s shops in producing turbine-motor stampings, both of which will be mentioned in this article. The laminations are stamped out in sections which are so arranged when assembled that the joints of adjacent laminations are offset in relation to each other. Fig. 20 shows a No. 95 Bliss press equipped with a sub-press for blanking out these stampings from strip stock. A stop is provided so that as the stock is passed through the dies, sufficient space is left between each stamping to enable another to be stamped out when the stock is reversed. This fact is evident by the appearance of the scrap which the operator is holding in one hand.

The compound blanking die used on this press is shown in section in Fig. 21. A three-pillar type of sub-press is used in this case, since the shape of the stamping adapts itself more readily to the use of three pillars than to an even number. The stock from which these stampings are made is 0.025 inch thick, and the shape is shown in both Figs. 20 and 22. Referring to Fig. 21, the upper holder *A* carries die *C* and one stripper *G*, movement of which is provided for by allowing a space between it and the templet *H*. The stripper is attached to the upper holder by a number of screws, the nuts of which fit in recesses in the holder to permit movement of the stripper. These screws and their nuts are prevented from turning by the same locking means used in other dies of this general construction. The lower holder *B* contains punch *D* and a stripper, also indicated by *G*, which is attached in the same way as the stripper in the upper holder. Pin *F* is carried on an extension arm at the

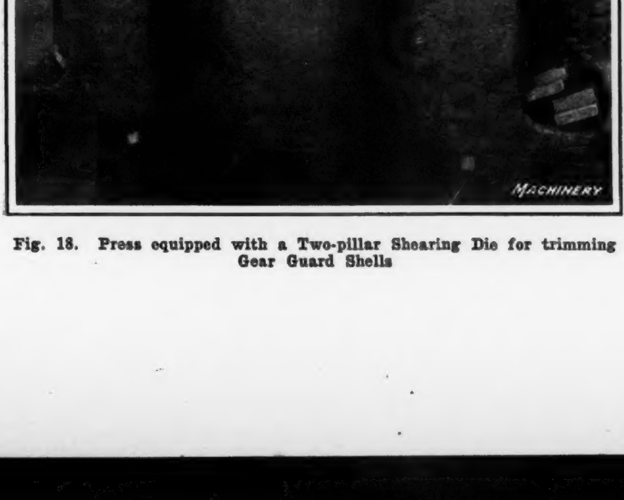


Fig. 18. Press equipped with a Two-pillar Shearing Die for trimming Gear Guard Shells

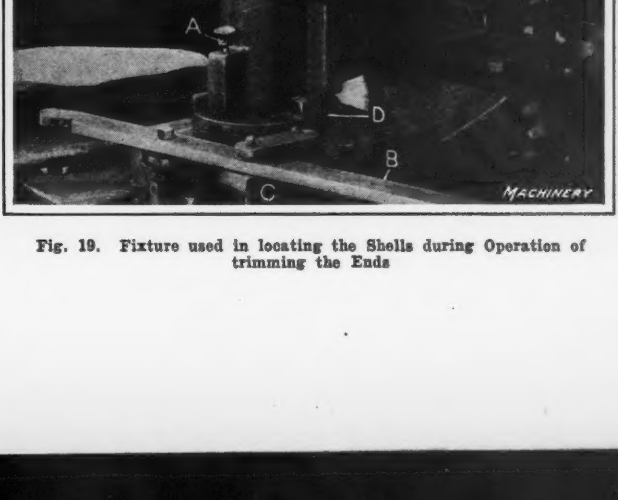


Fig. 19. Fixture used in locating the Shells during Operation of trimming the Ends

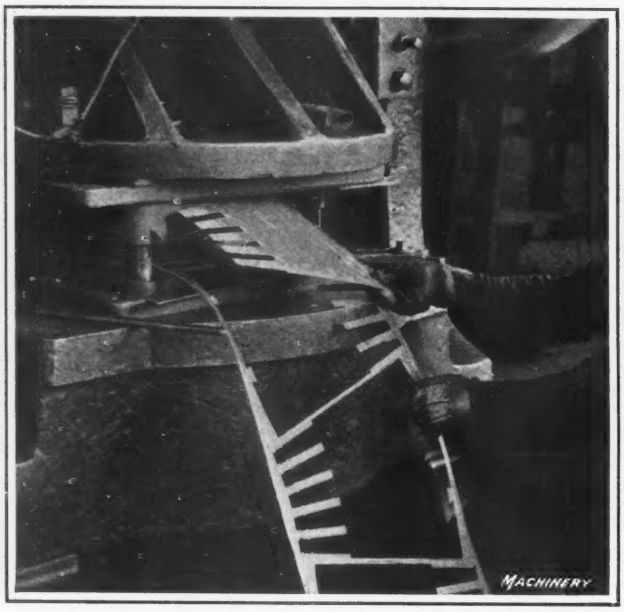


Fig. 20. Power Press equipped with the Dies shown in Fig. 21

rear of the sub-press, and locates the spacing of the stampings. The stock is located sidewise by means of two guide pins shown at *E*.

When these stampings are made by first blanking and then by punching the slots on a notching press as a separate operation, the method of holding the work for slotting is shown in Fig. 22. This illustration also furnishes an idea of the size of the rotor as well as the special mechanism employed to index the machine during the notching operations. The performance of the work by this method is, of course, somewhat slower than that previously described, but this machine may be operated by one man, whereas the feeding of strip stock requires a man at the front and one at the rear of the machine. This is a Ferracute press, and the fixture in which the stampings are placed holds eight parts, which have dovetailed sections stamped on the outer edge so that they may be located and held in position by corresponding lugs in the fixture. The operator stands at the right of the machine, and with one hand removes a finished stamping while with the other he loads a fresh one into position. As the fixture constantly revolves, the work is brought under a flat shoe *A*, which holds the work down by spring tension until the fixture has revolved sufficiently to bring the advancing edge under the head of the press. As the notches are stamped out and the finished work passes beneath a flat spring *B*, the fixture is indexed notch by notch by means of the mechanism shown at the left-hand side of the illustration.

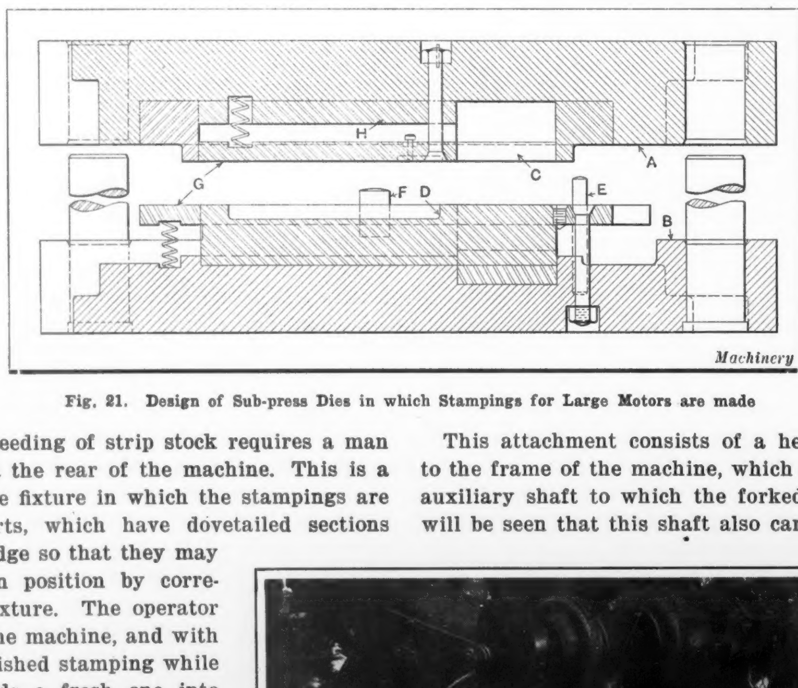


Fig. 21. Design of Sub-press Dies in which Stampings for Large Motors are made

Automatic Indexing Mechanism for Notching Operation

The automatic indexing mechanism by means of which the fixture is rotated is of similar design to that employed on certain other types of notching presses. The device illustrated, however, was especially designed for the performance of this notching operation. A slide, of which boss *C*, Fig. 22, is a part, reciprocates between two stop-collars. These collars are fastened to a curved rod *D* which is attached to a curved latch. The latch is provided with a notch which, when it enters the detent block *E*, forces the detent *F* from engagement with the notches in the periphery of the fixture. It is evident that when the notched latch is not in engagement, the detent locks the fixture by means of the tension exerted by a heavy coil spring. On the backward traverse of the slide, pawl *G* is pulled back a distance equal to the pitch of the notches, while the fixture is being held by the detent. The reciprocatory movement of the slide is transmitted by means of a universal joint connected with rod *H*, which is attached to a bellcrank lever. This bellcrank lever is given an oscillatory motion through its connection with a cam on the end of the crankshaft of the machine.

Although these notches are punched out very rapidly on the notching press, the production by this means does not equal that obtained on the machine equipped as shown in Fig. 20. The use of the notching press, however, does assure that the spacing of the notches for the entire set of stampings will be uniform, a fact which will be apparent by inspecting the method of holding the stampings in the fixture. The driving pulley is driven at 65 revolutions per minute, which is equivalent to an hourly production rate, allowing 10 per cent idle time, of about 575 stampings.

Automatic Feed and Stop for Strip Stock

In Figs. 23 and 24 there are shown partial rear and front views, respectively, of a power press equipped with two special automatic devices. This press is the product of the Niagara Machine & Tool Works, Buffalo, N. Y., and is provided with an automatic feed mechanism used when producing stampings of the design shown in the lower left-hand corner of Fig. 23.

This attachment consists of a heavy bracket *A*, attached to the frame of the machine, which contains bearings for an auxiliary shaft to which the forked arm *B* is attached. It will be seen that this shaft also carries two wide-faced spur

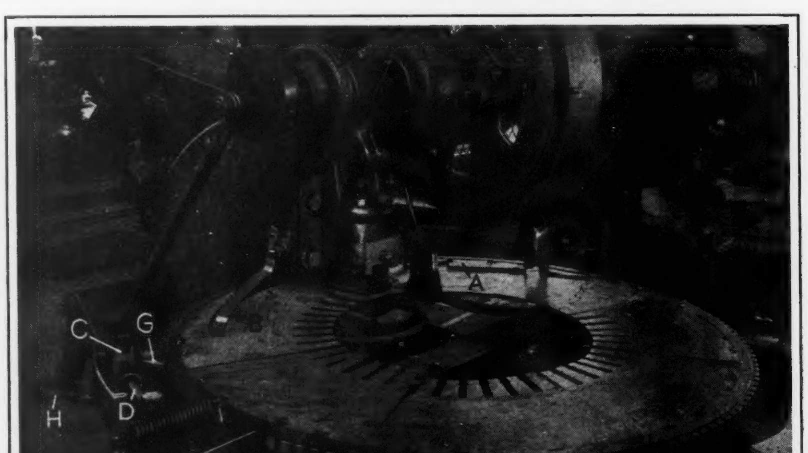


Fig. 22. Notching Press equipped with Automatic Indexing Mechanism, for punching out Slots in Large Motor Stampings

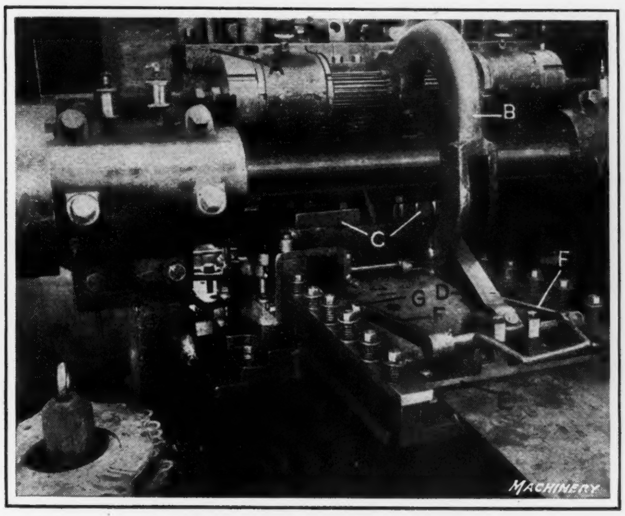


Fig. 23. Power Press with Special Attachment for automatically feeding Strip Stock into the Die when producing Stator Stampings

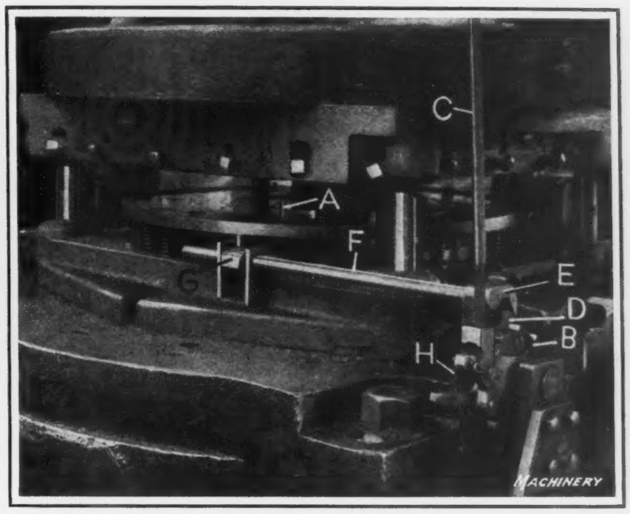


Fig. 24. Front View of Machine shown in Fig. 23, showing Automatic Stop that functions after the Strip has been completely used

gears, which mesh with racks carried in two upright bearings *C*, attached to the machine frame. It will be evident that as the ram of the press moves up and down, arm *B* will rise and fall accordingly. Through link *D*, which is hung in the forked arm, a reciprocatory movement is transmitted to slide *E*. The cross-shaft to which the connecting link is attached, carries two side arms *F*, in the further end of each of which there is an elongated slot. A roll *G* on each side of the slide is provided with a projecting pin or trunnion which extends into the slot in each side arm. The rolls are thus traversed back and forth with the slide with each rise and fall of the forked overhanging arm, a motion which results in advancing the stock at each stroke as determined by the length of the slide movement.

The feeding of the stock is accomplished by the downward pressure exerted by the side arms on the roll trunnions, binding them against the work during the downward movement of arm *B*. It is evident that normally the center of axis of the rolls would follow a horizontal plane and that the angle of the side arms produces an angle between the center line of the slots and a horizontal plane so that sufficient downward pressure is exerted on the trunnions in the slots to bind the rolls securely to the stock as a means of advancing it, as previously described. A bracket is bolted to the lower part of the machine for the purpose of supporting the slide. Two operators are employed on this job, one of whom feeds the stock into the machine at the rear while the other removes the finished work at the front of the machine. Another special automatic feature employed is a stop which is attached to the front of the machine and which is illustrated in Fig. 24. This mechanism is a ratchet device, as will readily be seen from the illustration, and operates a pin *A* which furnishes a stop for the work. The length of the strip stock is such as to enable nine stampings to be produced from it; consequently the ratchet wheel which controls the operation of the stop-pin has nine teeth.

This ratchet wheel *B* is supported by a bracket attached to the side of the machine, and is revolved one tooth at each upward traverse of the press ram. A connecting-rod *C* transmits motion to a pawl which operates the ratchet wheel in a clockwise direction. This pawl cannot be seen in the illustration, but it will be understood that it engages the teeth at the rear of the ratchet wheel and pulls downward with each upward travel of the press ram.

After the wheel has been revolved to the ninth tooth, a lug *D* on the wheel is brought into contact with pawl *E*, which results in turning the horizontal rod *F* and raising the stop-pin by means of arm *G*. It is evident that lug *D* is inoperative during the time that pawl *E* is not in engagement with the lug, and that the stop-pin is depressed, permitting the stock to pass over it as it is fed through the machine. A coil spring *H* raises the ratchet pawl so that it may be brought into engagement with the next ratchet tooth on the downward stroke of the press. Attention is called to the construction of the dies used for this work, which are of the sub-press type. The two operators employed on this job produce 1200 stampings per hour.

In the first installment of this article mention was made of the continued use of notching presses in electric motor shops. Not all the various types of stampings used on the large number of styles and sizes of motors are produced by means of multiple slotting dies; this is due partly to the excellent results obtained with the notching press on this type of work. A number of notching presses used in the General Electric Co.'s shop are shown in the illustration Fig. 25, which is a view in the press department of this company's works at Lynn, Mass.

Fig. 25. View in the Power Press Department showing Notching Presses, and giving Some Idea of the Variety of Shapes handled on these Machines

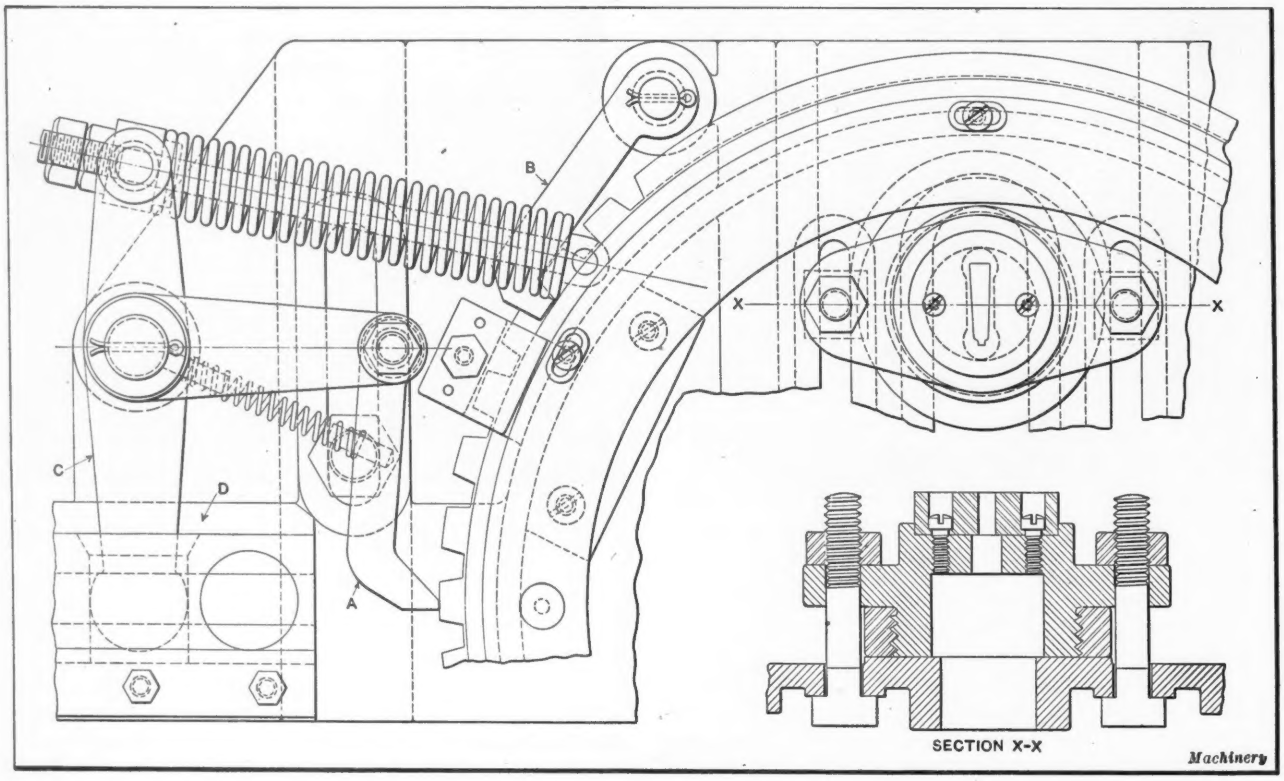


Fig. 26. Plan View of the Universal Automatic Indexing Fixture used on Notching Presses

Universal Automatic Indexing Fixture

The mechanism employed to rotate the fixture in which the work is held during the notching operation is of interest from a mechanical viewpoint and is illustrated in Fig. 27. In this illustration a motor stamping is shown located on the work-holding fixture, from which the nature of a large proportion of the work that these machines perform can be seen. This notching mechanism produces the same result as that described in connection with Fig. 22, but operates on a somewhat different principle. Fig. 26 shows a plan view of this mechanism and of a part of the holding fixture. The construction and operation of the indexing mechanism is as follows. Two pawls *A* and *B* are operated by their connection with a bronze bellcrank lever *C*. Pawl *A* is of the pusher type, and has a flexible spring connection with the bellcrank lever. Pawl *B* is of the hold-back type and is also operated by spring pressure through a rod at the end of the bellcrank lever, as shown in the illustration. The amount of tension thus produced may be varied by means of the adjusting nuts that are carried on the end of this rod.

Referring to both illustrations, the ball-end of lever *C* makes a universal joint in a sliding block *D*. Sliding lever *E* is also provided with a ball on the end for the purpose of transmitting motion to the sliding block as arm *F* is rocked back and forth by a connecting-rod attached to the crankshaft of the machine. It will be seen that as arm *F* oscillates, the sliding block *D* is made to reciprocate radially, so that when it is in the left-hand position, Fig. 26, pawl *A* is withdrawn and drags on the top of the teeth, as shown. At the same time, pawl *B* is engaged and holds the fixture during the notching operation; then, as the movement of bellcrank lever *C* is reversed, this pawl is raised while pawl *A* is engaged to advance the fixture the amount necessary to obtain the correct notch spacing. In Fig. 27 the method of holding the work and of locating it on the fixture is shown. The sectional view taken on line *X-X*, Fig. 26, shows the die opening, and the method of attaching and adjusting the die on the machine table.

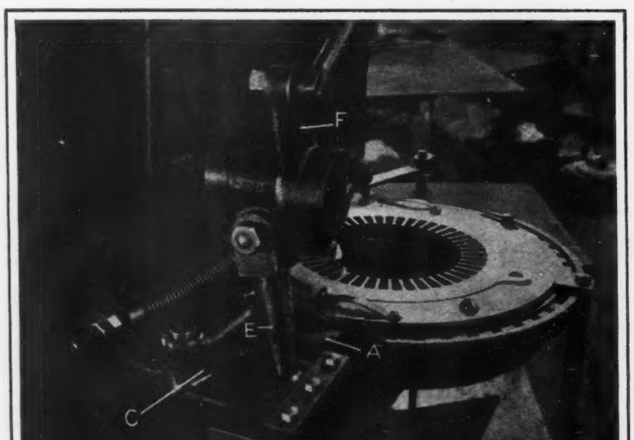


Fig. 27. Toledo Power Press with Automatic Indexing Mechanism attached and with Stator Stamping located in the Fixture

* * *

SOUTH AFRICAN INDUSTRIAL DEVELOPMENT

Official trade reports from the Union of South Africa show an enormous increase in the foreign trade of that country as compared with the trade for 1919. A considerable expansion is expected to take place in the industrial activities of South Africa, where many raw materials are abundant and where native labor is available. There is a growing demand for increased railway service, which the railways find difficult to meet because of shortage of cars, although new equipment is constantly being placed in service. Large quantities of rails, structural iron, plates and sheet iron, pig iron, etc., are required, as the country has no developed iron and steel industry. South Africa has, however, immense resources of iron ore and coal, and it is probably only a question of time when a large iron and steel industry will be developed within the union. One company was started in 1917 for the production of pig iron in a small way, the capital of this company having since been increased and now amounting to about £1,500,000. New machinery is being ordered for these works, and engineers are being engaged in Europe and the United States to develop the iron and steel industries in the Pretoria district.

Calculating the Strength of Unsymmetrical Sections

Two Methods of Determining the Moment of Inertia, Together with Formulas for Obtaining the Section Modulus and Radius of Gyration

By G. S. CHILES and R. G. KELLEY

In calculating the strength, size, and shape of members such as beams and columns contained in designs of engineering structures and machines, it frequently happens that an unsymmetrical section must be considered. The determination of a moment of inertia of such a section of complicated design is a long and tedious procedure. The usual method is to calculate the moment of inertia for each elementary part or element of the section about its own neutral axis, and then transfer this value to the neutral axis of the entire section. The addition of the moments of inertia of all the elements about the neutral axis of the section gives the moment of inertia of the latter.

The method of calculating the moments of inertia for unsymmetrical sections is a comparatively long and complicated one, and any procedure tending to make problems of this kind less formidable should be of value. The present article does not contain any principles that are not well known in mechanics, but rather compares two methods of calculating, and points out the advantage of one over the other. The clear, concise presentation of the formulas should permit them to be easily understood by the reader and should enable him to make future calculations with little difficulty.

A simpler method is to calculate the moment of inertia for each element with respect to an axis along one edge of the section and parallel to the neutral axis through the center of gravity. The sum of these moments of inertia gives the moment of inertia for the section with respect to the axis along its edge, from which the moment of inertia with respect to the neutral axis can be readily determined. The last method has a decided advantage over the first; in the following a specific problem will be solved in detail by each method in order to make this apparent. Both methods are applicable to either cast, rolled, or built-up sections. The moment of inertia for the section illustrated in Fig. 1 will be calculated about the horizontal or gravity axis 1–1. As the section is symmetrical about the vertical axis 2–2, the left half only will be considered in making the calculations. Therefore, the values for the area, moment of inertia, and section modulus of this half section should be multiplied by 2, or doubled, in order to obtain the respective values for the entire section.

Determining the Center of Gravity

For convenience in determining the center of gravity and moment of inertia, the half section represented at *A* in Fig. 2, is divided into a series of elementary areas or elements, represented by the five rectangles enumerated at *B*, each of which is separated and dimensioned at *C*. This scheme of cutting the section up into convenient elements is equally adaptable in the case of other plane figures, such as sections of a circle, etc. As the width and height of each element is known, the areas can be calculated as follows:

	Width	×	Height	=	Area	
(1)	2.25	×	0.81	=	1.82	square inches
(2)	1.88	×	1.44	=	2.71	square inches
(3)	0.63	×	12.14	=	7.65	square inches
(4)	1.78	×	0.81	=	1.44	square inches
(5)	2.13	×	1.44	=	3.07	square inches
Area of half section A				=	16.69	square inches

In determining the moment of inertia about the horizontal axis 1–1, Fig. 2, any parallel line such as the lower edge of the section, axis 0–0, may be selected as the line of reference. The distance to the center of gravity of each element from the axis 0–0 as, for example, 0.41 inch for element (1), 0.72 inch for element (2) etc., is shown at *C*. Designating this distance as d_0, the product of the area a of each element and its respective distance d_0 is its moment of area (which is also called the first moment of area); the values of these area moments for the five elements under consideration are calculated as follows:

	a	×	d_0	=	Area Moment
(1)	1.82	×	0.41	=	0.75
(2)	2.71	×	0.72	=	1.95
(3)	7.65	×	6.07	=	46.44
(4)	1.44	×	11.73	=	16.89
(5)	3.07	×	11.42	=	35.06
			Total M	=	101.09

By dividing the sum of the moments M, or 101.09, by the area of the half section, 16.69 square inches, which was previously found, the distance from the lower edge of the section (or axis 0–0) to axis 1–1, which passes through the center of gravity of the section, is determined. Thus,

$$\frac{M}{A} = \frac{101.09}{16.69} = 6.06 \text{ inches}$$

The distance from axis 0–0 to the gravity axis is therefore 6.06 inches. By subtracting this amount from the total height of the section, the distance of the center of gravity from the upper edge of the section is obtained. Thus,

$$12.14 - 6.06 = 6.08 \text{ inches}$$

Since the section in Fig. 1 is symmetrical about the vertical axis, the center of gravity of the section lies in the axis of symmetry. In this and similar problems, the computation of moments about a line perpendicular to the axis of symmetry is sufficient, since the center of gravity is at the intersection of axis 1–1 with the vertical axis of symmetry (axis 2–2).

Calculating the Moment of Inertia by the First Method

Having located the center of gravity of the entire section with respect to the upper and lower edges of the section, the distance between the reference axis through the center of gravity of each element and the gravity axis 1–1 of the entire section may readily be determined. These values are shown at *C*, Fig. 2, the distance being 5.65 inches for element (1), 5.34 inches for element (2), etc. The moment of inertia of the half section about its gravity axis may then be determined by means of the general formula

$$I_1 = I_g + (a \times d_1^2) \qquad (1)$$

in which

I_1 = the moment of inertia of any element in question about the axis through the center of gravity of the complete section parallel to the reference axis;

I_g = the moment of inertia of the element about its own center of gravity or reference axis;

a = the area of the element in square inches;

d_1 = the distance between the reference axis of the element through its center of gravity and the gravity axis 1–1 of the entire section.

Sections composed of plates, angles, channels, etc., are usually referred to as compound sections. The moment of inertia of a compound section about its neutral axis is equal to the sum of the moments of inertia of the elements about the neutral axis of the section. The moment of inertia is designated by the letter I, the subscripts being added merely to indicate which axis is used. Thus, I_1 and I_0 mean moment of inertia about axes 1–1 and 0–0.

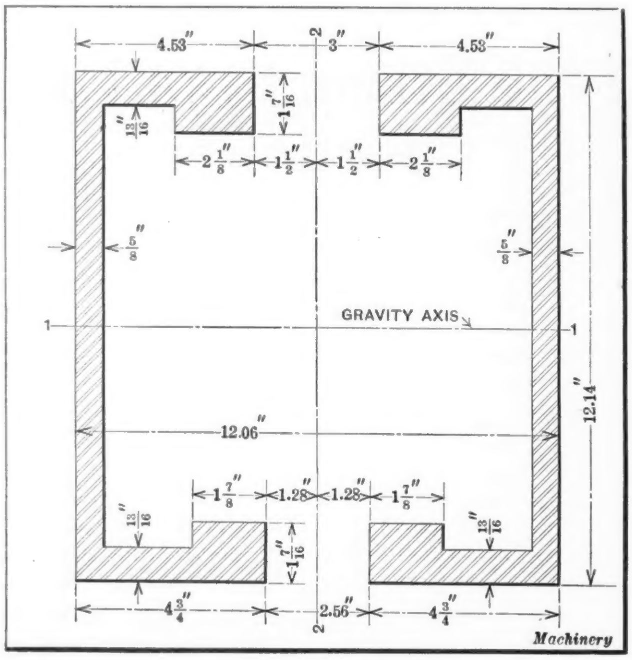


Fig. 1. Unsymmetrical Section for which the Moment of Inertia about its Gravity Axis, the Section Moduli, and the Radius of Gyration will be calculated

The moment of inertia for a rectangle with respect to an axis through its center of gravity is expressed by the following equation,

$$I_g = \frac{bh^3}{12}$$

in which b = width of rectangle in inches;
h = height of rectangle in inches.

The following computations are necessary to determine the moment of inertia I_g of each element:

$$(1)\quad I_g = \frac{2.25 \times 0.81^3}{12} = 0.10$$

$$(2)\quad I_g = \frac{1.88 \times 1.44^3}{12} = 0.46$$

$$(3)\quad I_g = \frac{0.63 \times 12.14^3}{12} = 93.93$$

$$(4)\quad I_g = \frac{1.78 \times 0.81^3}{12} = 0.08$$

$$(5)\quad I_g = \frac{2.13 \times 1.44^3}{12} = 0.53$$

$$\text{Total } I_G = 95.10$$

The moment of inertia I_1 of each element is calculated by Equation (1) and presented in Table 1. The sum of all the moments of inertia of the elements is 364.96, which is the moment of inertia of the half section about its gravity axis 1–1. The moment of inertia of the entire section is found by doubling the amount, as previously stated, thus, $2 \times 364.96 = 729.92$, the moment of inertia of the entire section.

Determining the Moment of Inertia by the Second Method

The second method of determining the moment of inertia of the half section with respect to the axis 1–1 is based upon the following equation:

$$I_1 = I_0 - (A \times D^2) \qquad (2)$$

in which I_1 = moment of inertia of half section about axis 1–1;

I_0 = moment of inertia of half section about axis 0–0;

A = area of half section;

D = distance from axis 0–0 to axis 1–1.

It is evident that this method involves the determination of the moment of inertia of the half section about an axis such as 0–0 and the transferral of this moment of inertia to a parallel axis 1–1, which passes through the center of gravity of the entire section. In this case, the areas of the elements and of the half section are determined as in the previous case and are the same. The moments of these individual areas about axis 0–0 are also determined as previously.

These moments of area which have been designated as the first moments of area were determined by the formula ($a \times d_0$), but in transferring the moments of inertia from one axis to another, a second moment appears. These second moments of area are obtained by multiplying each element by the square of the distance from its gravity axis to the reference line 0–0, the mathematical formula being ($a \times d_0^2$). The values for the first moments of area were previously calculated, and it is merely necessary to multiply each of these values by d_0 in order to obtain the second moments of area. Putting this in the form of an equation, and substituting the values for each element, we have:

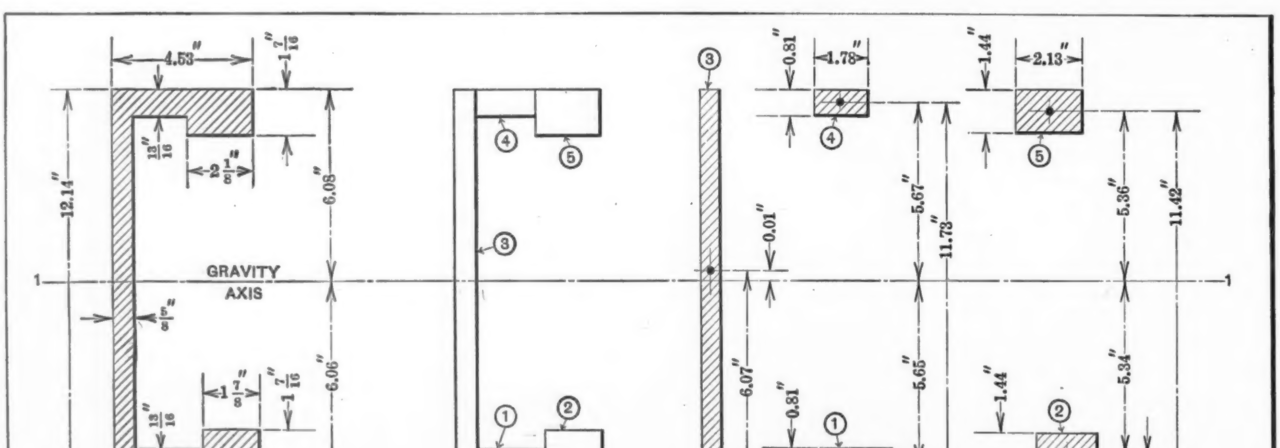


Fig. 2. Method of dividing the Section into Elements to facilitate the Determination of the Center of Gravity and the Moments of Inertia

First Area Moment ad_0 × Distance Arm d_0 = Second Area Moment ad_0^2

$$
\begin{array}{lrcrcr}
(1) & 0.75 & \times & 0.41 & = & 0.31 \\
(2) & 1.95 & \times & 0.72 & = & 1.40 \\
(3) & 46.44 & \times & 6.07 & = & 281.89 \\
(4) & 16.89 & \times & 11.73 & = & 198.12 \\
(5) & 35.06 & \times & 11.42 & = & 400.39 \\
\hline
 & & & \text{Total } M_1 & = & 882.11
\end{array}
$$

In this method, as in the first one, the moment of inertia of each element about its own gravity axis enters into the calculations, and these values may be obtained in the foregoing. All of the values required in Equation (2) can now be determined. The value of the total second moments of area M_1 was calculated to be 882.11, and the sum of all the moments of inertia of the elements about their own centers of gravity I_G was found to be 95.10. Therefore I_0 in Equation (2) can be determined by the following equation:

$$I_0 = I_G + M_1$$

or

$$I_0 = 95.10 + 882.11 = 977.21$$

Substituting the known values in Equation (2), we have:

$$I_1 = 977.21 - (16.69 \times 6.06^2)$$

and

$$I_1 = 977.21 - 612.92 = 364.29$$

The moment of inertia for the entire section is, of course, double this amount, or 728.58, which is approximately the same as the value obtained by the first method, the difference being due to not carrying the calculations out to a sufficient number of decimal places.

Finding the Section Moduli of the Section

The quantity $\frac{I}{y}$ is known as the modulus of the section or as the section modulus, and is in effect a relative measure of the strength of a section to resist bending. For sections which are symmetrical about the gravity axis, the modulus of the section is equal to the moment of inertia divided by half the depth of the section. Thus, y represents the distance in inches from the gravity axis of the section to the extreme outer edge of the section. The letter Z is ordinarily employed to designate the quantity $\frac{I}{y}$, that is, $Z = \frac{I}{y}$.

In the example under consideration the axis 1–1 through the center of gravity, which may also be termed the neutral axis for bending, does not fall midway between the extreme lower and upper edges of the figure, and as a result there are two section moduli. With respect to the lower edge of the section, the distance y from the neutral axis is 6.06 inches; hence the section modulus of the half section with respect to the bottom edge, if the moment of inertia obtained by the second method is used, is as given in the following equation:

TABLE 1. CALCULATING I_1 FOR EACH ELEMENT AND THE HALF SECTION

$$I_g + (a \times d_1^2) = I_1$$

$$(1)\ \frac{2.25 \times 0.81^3}{12} + (1.82 \times 5.65^2) = 0.10 + 58.09 = 58.19$$

$$(2)\ \frac{1.88 \times 1.44^3}{12} + (2.71 \times 5.34^2) = 0.46 + 77.28 = 77.74$$

$$(3)\ \frac{0.63 \times 12.14^3}{12} + (7.65 \times 0.01^2) = 93.93 + 0.00 = 93.93$$

$$(4)\ \frac{1.78 \times 0.81^3}{12} + (1.44 \times 5.67^2) = 0.08 + 46.29 = 46.37$$

$$(5)\ \frac{2.13 \times 1.44^3}{12} + (3.07 \times 5.36^2) = 0.53 + 88.20 = 88.73$$

I_1 for the half section A, Fig. 2 = **364.96**

Machinery

TABLE 2. CALCULATIONS FOR FINDING MOMENT OF INERTIA AND SECTION MODULUS IN COMPACT FORM

Element	Size, Inches	a Area, Sq. In.	d_0 Arm, Inch	ad_0 First Moment	ad_0^2 Second Moment	I_g Moment of Inertia
1	2¼ × 13/16	1.82	0.41	0.75	0.31	0.10
2	1⅞ × 1 7/16	2.71	0.72	1.95	1.40	0.46
3	⅝ × 12.14	7.65	6.07	46.44	281.89	93.93
4	1.78 × 13/16	1.44	11.73	16.89	198.12	0.08
5	2⅛ × 1 7/16	3.07	11.42	35.06	400.39	0.53
	Total	A 16.69	......	M 101.09	M_1 882.11	I_G 95.10

$$I_0 = I_G + M_1$$

where I_0 = moment of inertia of half section about axis 0 – 0

Therefore

$$I_0 = 95.10 + 882.11 = 977.21$$

$$D = \frac{M}{A} = \frac{101.09}{16.69} = 6.06 \text{ inches}$$

where D = distance from axis 0 – 0 to axis 1 – 1

Then distance from axis 1 – 1 to the top edge of the section is 12.14 — 6.06 = 6.08.

$$I_1 = I_0 - (A \times D^2) = 977.21 - (16.69 \times 6.06^2)$$
$$= 977.21 - 612.92 = 364.29$$

where I_1 = the moment of inertia of half section about the gravity axis 1 – 1

Therefore the moment of inertia about axis 1 – 1 for the entire section is

$$2 \times 364.29 = 728.58.$$
$$Z_b = 364.29 \div 6.06 = 60.11$$
$$Z_t = 364.29 \div 6.08 = 59.92$$

Machinery

$$Z_b = \frac{364.29}{6.06} = 60.11$$

Similarly, the section modulus of the half section with respect to the top edge equals

$$Z_t = \frac{364.29}{6.08} = 59.92$$

Formula for Radius of Gyration

The radius of gyration is that property of the cross-section of a column which determines its strength. The relation of the radius of gyration R to the moment of inertia I and the area of the cross-section A, is such that it equals the square root of the quotient resulting from dividing the former by the latter, or

$$R = \sqrt{I \div A}$$

The radius of gyration is used in designing columns, and as the least radius of gyration is usually desired, it is important to select the axis where the moment of inertia is minimum.

Advantage of Second Method over First

In the foregoing, the specific problem selected has been analyzed in detail. A more condensed or abbreviated computation of this problem is presented in Table 2, wherein the values are obtained by means of the second method of analysis which has been described. Familiarity with calculations such as those given in this table would undoubtedly result in a still further abbreviated form. This would, of course, vary with the individual calculator, but where the calculations are to be submitted to others there is a possibility of abbreviating to such an extent that clearness would be doubtful.

In regard to the relative advantages of the two methods of calculation which have been presented, it is evident that the second is in some respects much to be preferred to the first. In case it is found necessary to recalculate the section, due either to an error in the calculation or a subsequent alteration in the location or size of some element of the section, it will be noted that if the calculations have been

made according to the second method it will not be necessary to recalculate to the extent required if the first method had been employed. This is due to the fact that a change in the location of the neutral axis in the first method necessitates a change in all of the quantities in which it occurs, whereas only a few extra calculations are necessary if the second method has been employed.

An alteration in the size of any of the elements of the section shown in Fig. 2, such as a decrease in the thickness of element (5) from 1 7/16 to 1⅜ inches will illustrate how much additional work would be required in a set of calculations based upon the first method, whereas all the values other than those having reference to the particular element concerned, would still be valid if determined by the second method. In designing cast sections, several calculations are usually required, and in this work the advantage of the second method becomes apparent.

* * *

WALL DRAFTING MACHINE

The saving of time, the maintenance of accuracy, and the numerous other advantages that may be derived from the use of drafting machines are common knowledge. There is hardly a drafting department in which at least one of these time-saving devices is not employed. In connection with the experimental work in the engineering department of Gould & Eberhardt, Newark, N. J., a drafting machine that is hung to the wall is found a most convenient means of sketching the design of contemplated machines. The machine is used in connection with a blackboard, and the convenience with which the device can be operated when machinery is being laid out to full scale, is shown in Fig. 1.

The carriage on which the frame of the machine is held is operated lengthwise of the blackboard by means of a trolley and track. This track is hung to the wall by suitable brackets. The frame consists of a vertical rod and an angular one, the diameter of each being 1¼ inches. The vertical rod is the guide and support for the drafting machine proper, which is connected by wires that pass over suitable pulleys to the weight which rides on the angular shaft.

In making this drafting machine, the main quadrant casting *A*, Fig. 2, was made from aluminum so as to provide a lighter section. There are four fiber rollers employed to guide the machine as it is raised and lowered on the vertical rod, two of these being located at the top of the aluminum casting and two at the lower part. Rolls *B* are carried in

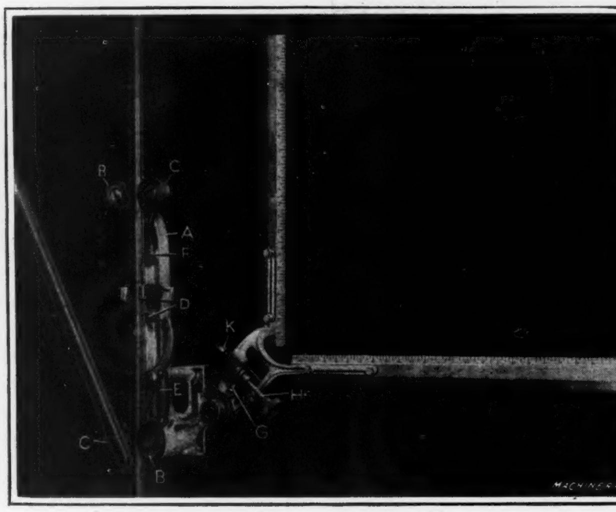


Fig. 2. Detail View of Drafting Machine shown in Fig. 1

a fixed bearing, while rolls *C* are located on opposite sides of the rod and are each carried by a swiveling aluminum lever which is attached to the main aluminum casting. These levers extend in opposite directions so that the extending finger of each may be connected by coil spring *D* for the purpose of providing a firm rolling contact with the rod and thus maintain absolute parallelism between the rod and the movement of the quadrant casting. This condition is, of course, essential, as otherwise the accuracy of the entire drafting machine would be destroyed.

The machine is operated by the draftsman's grasping the fiber handle *E*, after the locking screw *F* has been released. This locking screw is carried in one of the two lugs that project from the aluminum casting, so that the device may be securely held in the desired vertical position. These two projecting lugs by reason of their straddling the vertical shaft, furnish an additional means of preventing sidewise movement of the aluminum casting. The segment gear and worm, by means of which the scales may be set at any angle, are plainly shown in the illustration. The segment gear is graduated, and there is a pointer *G* by means of which the scales may be set in horizontal and vertical positions as desired. The worm-shaft *H* has a knurled knob at one end by means of which this setting may be obtained, and a graduated collar *K* at the opposite end for obtaining settings to minutes of a degree. The length of each scale is 20 inches, and the size of the blackboard is 20 by 12 feet.

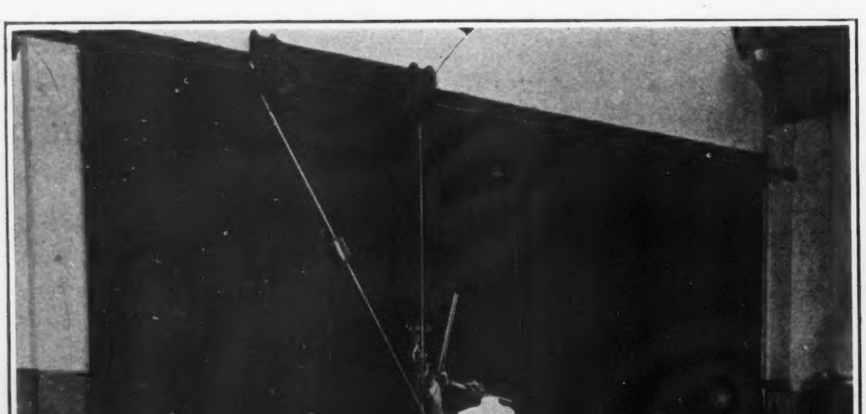


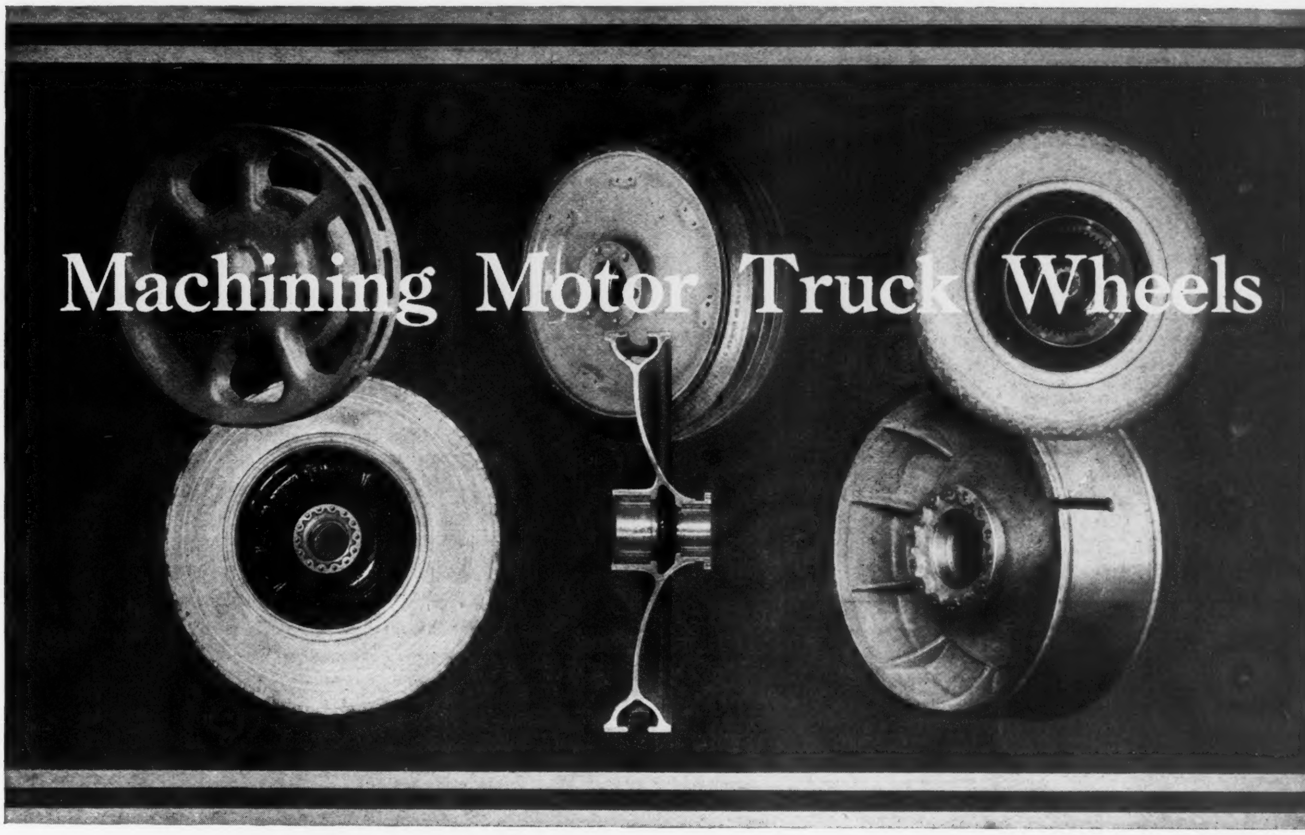
Fig. 1. Wall Drafting Machine, and Blackboard used in Connection with it

* * *

IDENTIFICATION OF PIPE LINES

In a publication issued by the Davis-Bournonville Co., Jersey City, N. J., attention is called to the fact that the scheme of marking shop piping with various colors to designate what they convey is not entirely satisfactory on account of there not being a sufficient number of primary colors to designate all fluids carried by pipes. Any method of simple color designation adopted necessarily applies only to the conditions of a particular plant, and every plant requires different color schemes or color combinations, bands, etc. The main pipes usually marked are for water, steam, compressed air, gas, and oil, but in some plants there may be several kinds of water pipes. A preferable system would be to stencil each pipe with the name of the fluid it conveys, at intervals throughout its length, or at the inlet and outlet valves.

Machining Motor Truck Wheels



Practice of the Clark Equipment Co., Buchanan, Mich., in the Production of Steel Truck Wheels

EACH succeeding year witnesses a more pronounced trend toward specialization in industry. Today each man has his specific task, and through constant practice and experience he is able to attain a wonderful degree of efficiency in its performance. This principle has been further applied in the manufacture of various products, where individual parts are made in different plants working on contracts for firms that take the finished parts and assemble them into completed units for distribution to the trade. Greater economy can be secured in this way, because each manufacturer concentrates all his energies upon the production of one class of work. Some firms employ this method of having all of the parts of their product made under contract, while others have only a few parts produced in this way, depending upon their own shops to furnish the majority of parts required.

Specialization in Machining Motor Car Parts

One of the outstanding examples of specialization in the production of parts made under contract with firms that assemble them ready for shipment is found in the motor car industry, in which there are many plants devoting themselves entirely to the manufacture of wheels, axles, transmissions, and numerous other parts. One such firm is the Clark Equipment Co., of Buchanan, Mich., which specializes in the manufacture of rear axles and steel wheels for motor trucks. In the May and June numbers of MACHINERY, two articles were published on the methods used in this company's plant for manufacturing axles; it is the purpose of the present article to explain interesting features of the shop practice in making steel truck wheels. The Clark Equipment Co. manufactures a very large number of different types of truck wheels, including both the so-called "steel disk wheel," the machining operations on which are described in the following, and the "spoked" type of wheel.

Steel Foundry Practice in Making Truck Wheels

The articles describing the manufacture of rear axles contained a general description of the facilities of the steel

Fig. 1. View in the Foundry showing the Facilities for mixing and carrying Sand

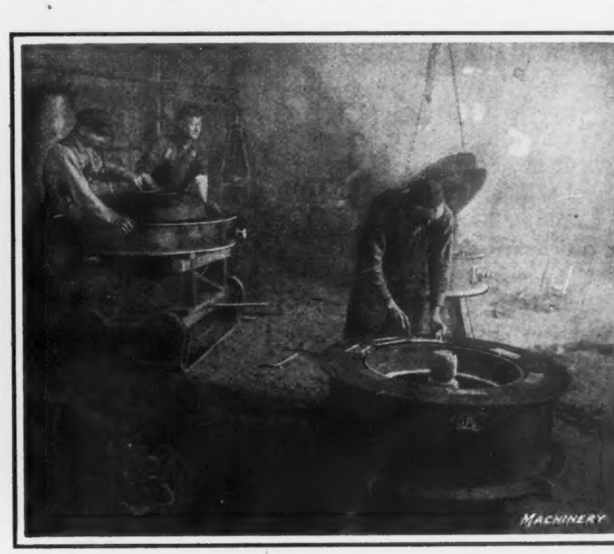


Fig. 2. Molding a Steel Disk Wheel in the Clark Equipment Co.'s Foundry

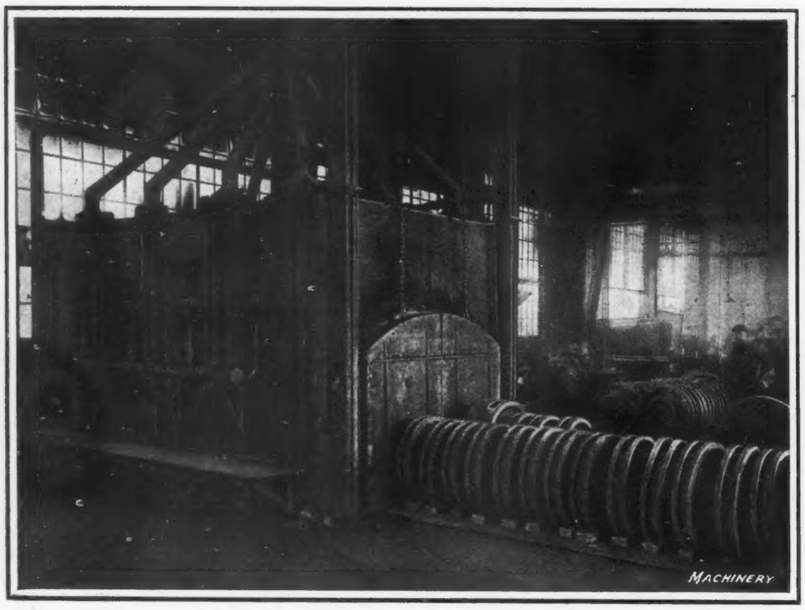


Fig. 3. View of an Annealing Furnace, showing a Charge of Steel Disk Wheels Ready to be heat-treated

foundry, so that at the present time it only remains to outline briefly the methods employed in molding the various types of wheels and in preparing the castings for delivery to the machine shop. It is found feasible to repeatedly use the molding sand, provided a suitable amount of new sand is added each time the molds are broken up, but all core sand is discarded after being used once. The molds are packed in a jolting machine built by the Osborn Mfg. Co. of Cleveland, Ohio, and in order to obtain the desired results it is important to employ a specified number of jolts in packing each mold to obtain the proper degree of density for the sand.

After the steel has been poured into the molds, sand is removed from the castings by tumbling them in a shaker; then the gates are broken off and the risers are cut off with an oxy-acetylene torch. Following this part of the work, the next step is to sand-blast the castings to remove all adhering sand, scale, and slight surface imperfections. Sand-blasting is done in an enclosed room, and before this operation all of the castings are subjected to a general inspection so that those with obvious defects may be discarded. Following the sand-blasting operation, the next step is to rough-grind the castings on grinding stands, with the work suspended from a trolley hoist so that its position may be easily adjusted relative to the wheel. All castings are next sent to a special gas furnace in which they are annealed at a temperature of 1650 degrees F. for about two hours. Fig. 3 shows one of these annealing furnaces, where it will be seen that provision is made for loading the work on a car that can be run into the furnace, after which the door is closed and sealed with fireclay.

About five hours' time is required to raise the temperature of the work to 1650 degrees F., and after being held at this temperature for two hours, another five hours is needed to allow the temperature to decrease sufficiently to allow the castings to be withdrawn from the furnace. Hence, it will be apparent that each furnace may be arranged to anneal two charges of work in twenty-four hours. After coming from the annealing furnace, the castings are again sand-blasted to remove any small amount of scale or burnt sand which may still be adhering to their surfaces, and they are then chipped with air hammers to remove any metal that is protruding much above the normal surface. Welding torches are then employed to cover up any surface defects. Finally, the castings are finish-ground with a portable electric grinder driven by a flexible shaft as shown in Fig. 4, and they are then sent to the inspection department, where a complete visual inspection is given to each casting in order to avoid having the machine shop perform work on castings which later will be found unsuitable for use.

Machining Operations on Steel Disk Wheels for Nash "Quad" Trucks

A large majority of the parts for passenger cars and trucks made by the Nash Motors Co. are manufactured in this company's plant in Kenosha, Wis., but a practice is made of having some of the parts made by specialists. Steel disk truck wheels are a case in point, and Fig. 5 shows the type of wheel used on the so-called Nash "Quad" truck that is equipped with a four-wheel steering mechanism. In machining these steel castings, there are three series of operations performed on vertical turret lathes. First, the work is set up on a Bullard 36-inch machine which is equipped with a four-jaw independent chuck that grips the casting on the inside surface *A* of the brake-drum. Height blocks are placed under the edge of the rim for leveling up the casting, and tools mounted on the first face of the turret provide for facing surfaces *B* on the hub and *C* on the rim. A tool on the side-head is next utilized for turning the outside diameter *E*; and a formed tool carried by this side-head is next brought into operation to provide for turning surfaces *F* and *G* that are beveled to an angle of 18 degrees to form a seat for the pneumatic tire rim.

Second Setting of the Work

When these operations have been completed, the work is transferred to the Bullard machine illustrated in Fig. 6, which is provided with a fixture having seats to locate the work on its beveled face *F*, Fig. 5, the work being held with the drum *A* facing upward. Referring to Fig. 6, it will be seen that the side-head is furnished with a tool *H* that provides for facing surface *I*, Fig. 5. On the first face of the turret there are two tools *J* and *K*; tool *J* is used for finishing surfaces *L* and *M*, and tool *K* roughs the drums *A*. After indexing the turret, tool *N* is brought into operation to provide for finishing the drum *A* and the gear-ring seat *O*,

Fig. 4. Grinding Department of the Foundry where Surface Defects are removed from Castings before machining

and after taking a roughing cut, a second cut is taken over these surfaces with the same turret tool. Indexing the turret now brings two tools P and Q into operation to provide for taking a roughing cut in bore R of the hub and on the outside diameter S. Tool T is next utilized for finish-boring surface R, after which reamer U is brought into action to finish the bore to exactly the required diameter. Next in the order of operations comes the use of tool K a second time to provide for cutting the relief V on the horizontal surface of the rim.

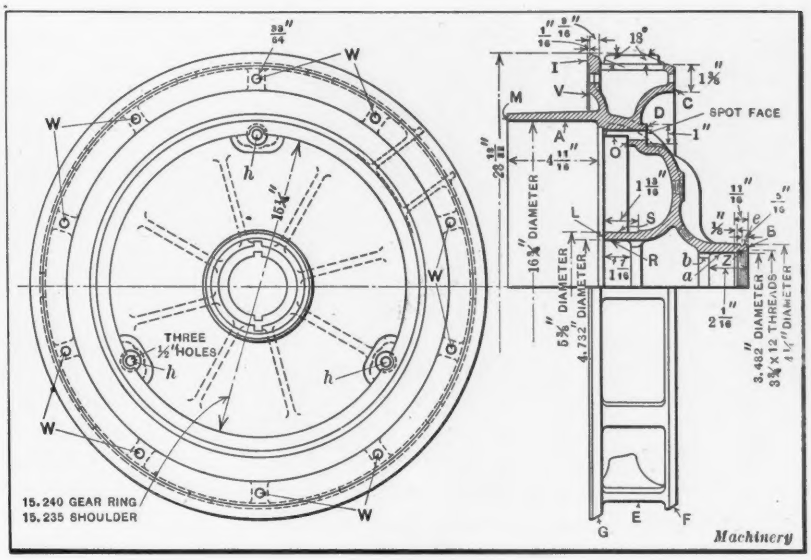


Fig. 5. Side and Cross-sectional Views of a Steel Disk Wheel for the Nash "Quad" Motor Truck

turret face is provided with three cutters for finish-boring holes a and b and finish-facing surface B. On the third turret face there will be seen two tools d which provide for cutting the locking groove e and the thread release groove at the bottom of hole Z. In the fourth turret face a Geometric collapsible tap f is carried, for cutting the thread in hole Z, and on the fifth face of the turret there is mounted a reamer g for reaming the diameter of hole a.

Third Sequence of Operations

Following the performance of the operations which have just been described, the next step is to drill ten 33/64-inch holes W in the rim, a Cincinnati-Bickford upright drilling machine being employed for this purpose. This is an ordinary drilling operation. The work is next transferred to a 28-inch Colburn vertical boring and turning mill shown in Fig. 7, on which the third sequence of operations is performed. It will be apparent from this illustration that the work is held in the same position as for the first setting. There are leveling blocks on the table on which the casting is clamped down by means of bolts x, and the casting is accurately located by a screw at the center which is tightened to expand four pins inside of the bore R, Fig. 5. On the first face of the turret there is a quadruple tool Y that provides for rough-boring three diameters Z, a, and b in the hub and rough-facing the surface B. A tool c on the second

Next in the order of operations to be performed on these wheels comes the drilling of three half holes h, Fig. 5, that are subsequently used for clamping a gear ring in place. These holes are ½ inch in diameter. This would be a perfectly simple operation were it not for the fact that the holes have to be drilled in such a way that half of the drill is cutting into the perpendicular wall of the work, while the other half is running in free space. To all experienced mechanics it will be apparent that a job of this kind is likely to cause trouble, owing to the tendency of the drill to run out of the path which it is intended to follow, but the possibility of difficulty from this source is effectually overcome by employing a very simple expedient. It will be recalled that the gear-ring seat O was finished during the second sequence of boring mill operations, and for use in drilling the three holes h, dummy rings cast from the same kind of steel as the truck wheels are turned up to the same diameter as the gear ring so that they may be dropped into place preparatory to drilling the necessary holes, and thus support the drill during the operation.

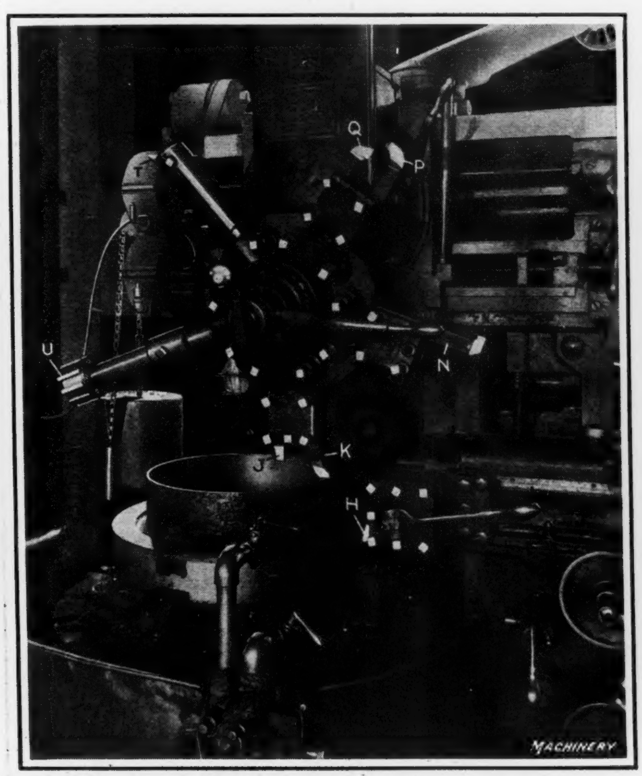


Fig. 6. Vertical Turret Lathe for performing Second Sequence of Operations on Nash "Quad" Wheels

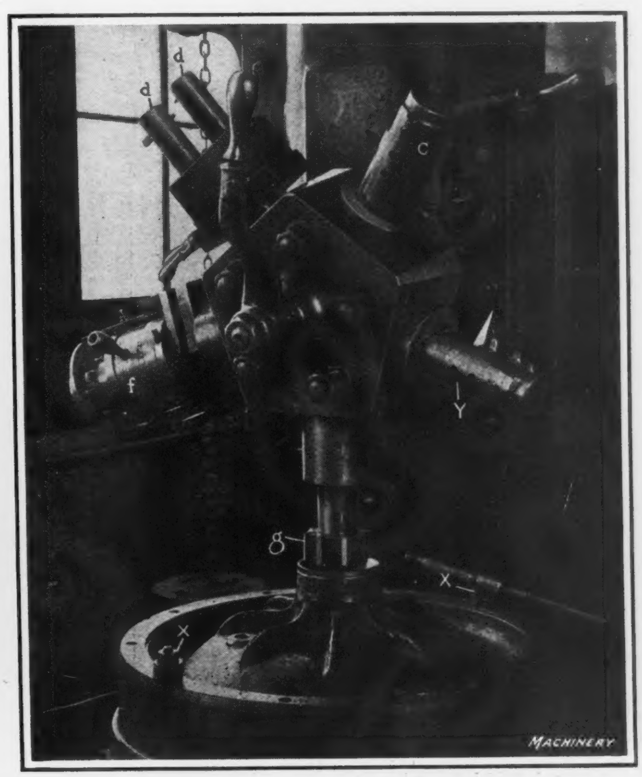


Fig. 7. Boring Mill equipped for performing Third Sequence of Operations on Nash "Quad" Wheels

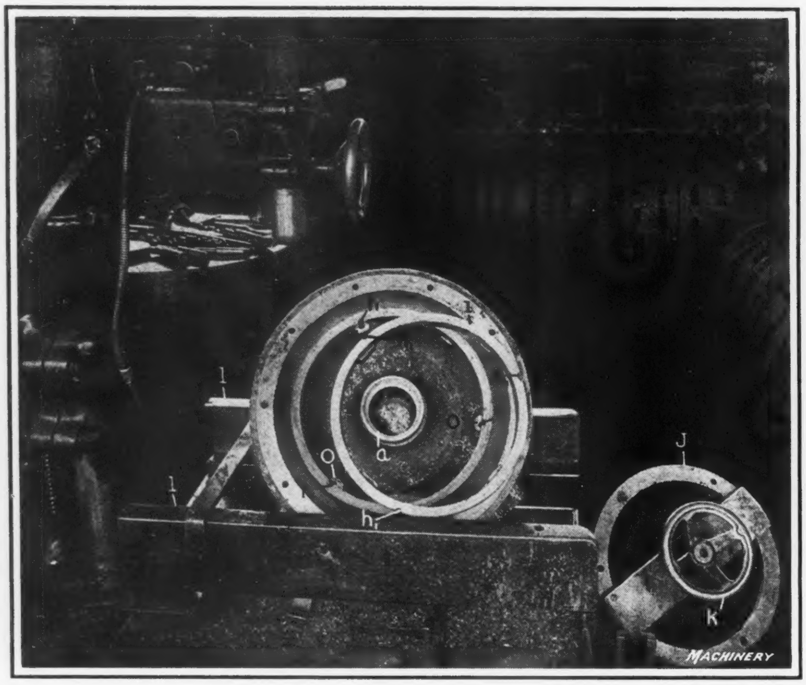


Fig. 8. Vertical Drilling Machine with Jig for Use in drilling Half Holes in Gear-ring Fit

The best idea of the manner in which this operation is performed will be gathered by referring to Fig. 8, where a Cincinnati-Bickford vertical drilling machine is shown equipped for handling this job. In this illustration it will be evident that the same reference letters are used to denote finished surfaces as are used in Fig. 5. The cast-steel ring *i* is used for supporting the drills while three holes *h* are being drilled, and it will be evident that the half holes produced in this ring are indicated by h_1. It so happens that the ring shown in this illustration has been used only once, but in practice this ring will be used repeatedly, by slightly shifting its position each time, until a complete series of half holes h_1 are cut all around its circumference, after which the ring will be discarded. Aside from this method of supporting the drills there is nothing of exceptional interest in regard to this operation.

It will be seen that a quite simple form of jig plate *J* is employed, which has three drill bushings mounted in it and a handwheel *k* that provides for clamping the jig in place on the work. This jig is piloted in the finished bore *a* of the casting, and it will be evident that the casting is laid over two rails *l*, so that after each hole *h* has been drilled, it may be turned through one third of a revolution to bring the work into position for drilling the next hole. One of these so-called "dummy rings" is used to drill thirty wheels before it has to be discarded. After drilling the three holes *h* in the truck wheel casting, the drill jig is removed and a counterbore is mounted in the drilling machine spindle to provide for counterboring the holes to a depth of 1/4 inch. After this has been done, the work is subjected to the usual inspection before being painted. On this job the production time is as follows: First setting on Bullard vertical turret lathe, thirty minutes; second setting, vertical turret lathe, fifty minutes; drilling ten holes *W*, Fig. 5, twenty minutes; machining operations on Colburn boring mill, fifteen minutes; drilling three holes *h*, fifteen minutes; making the total machining time two hours and ten minutes. A few other detail operations still have to be performed on these wheels before they are ready for shipment, but as they involve no unusual features, they are not described here.

Machining Rear Wheels for Packard Five-ton Trucks

A majority of parts for motor trucks built by the Packard Motor Car Co., are manufactured in this company's plant in Detroit, Mich., but the Clark Equipment Co. makes the steel disk wheels for use on these trucks. Fig. 9 shows two views of the type of double disk rear wheel for the Packard five-ton truck. The first sequence of operations on these castings is performed on a Bullard vertical turret lathe, Fig. 10, equipped with a side-head and a four-jaw chuck for holding the work from the inside of the rim, the chuck jaws being provided with points that dig into the work to afford the necessary driving power. Reference to the cross-sectional view in Fig. 9 will at once make it apparent that this wheel is of the so-called "double disk" type; that is to say, there are two walls of steel projecting inward from the rim to the hub, the purpose being to provide a liberal amount of strength so that ample carrying capacity is assured.

In starting the machining operations, the side-head begins roughing the outside diameter *A* of the rim, and as soon as this side-head has moved its tool down far enough to afford the necessary amount of clearance, a turret tool is brought into action to start facing the top of the rim. After this turret tool has completed its work on surface *B*, the turret is raised 1 1/8 inches and traversed over to bring the tool into engagement with surface *C* on the hub which is faced by the same tool. A second cut is taken over these surfaces with this tool to provide for obtaining the desired perfection of finish. On the same face of the turret there is a second tool that is utilized for turning the outside diameter *D* of the hub. Mounted on the next turret face there is a tool used for facing the chain hook lugs *E*, and after this part of the work has been completed the side-head is indexed to bring a finishing tool into position for starting a second cut over the outside diameter *A* of the rim.

It is important to have this diameter quite accurate, and for use in testing the size of the work a special circumference gage has been made, which consists of a steel tape measure that is arranged to embrace the turned surface of the work, handles being provided at both ends of the tape by means of which they are drawn together. As the movable end of the tape slides through the frame of the gage, it

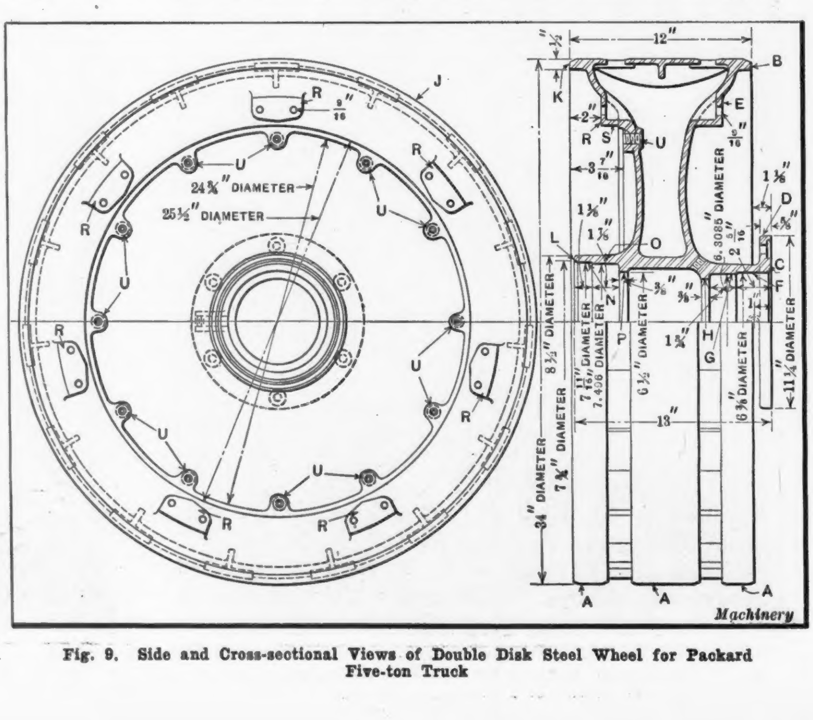


Fig. 9. Side and Cross-sectional Views of Double Disk Steel Wheel for Packard Five-ton Truck

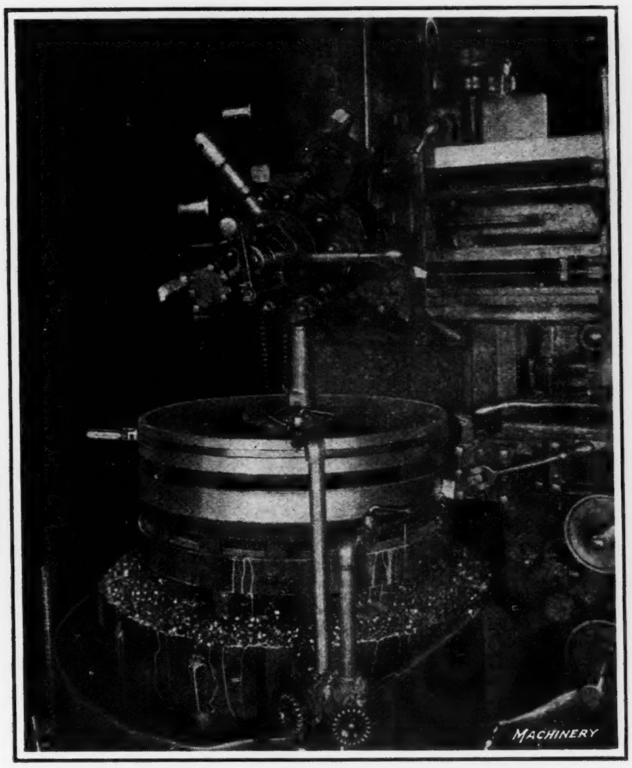


Fig. 10. Vertical Turret Lathe equipped for performing First Sequence of Operations on Packard Five-ton Truck Wheels

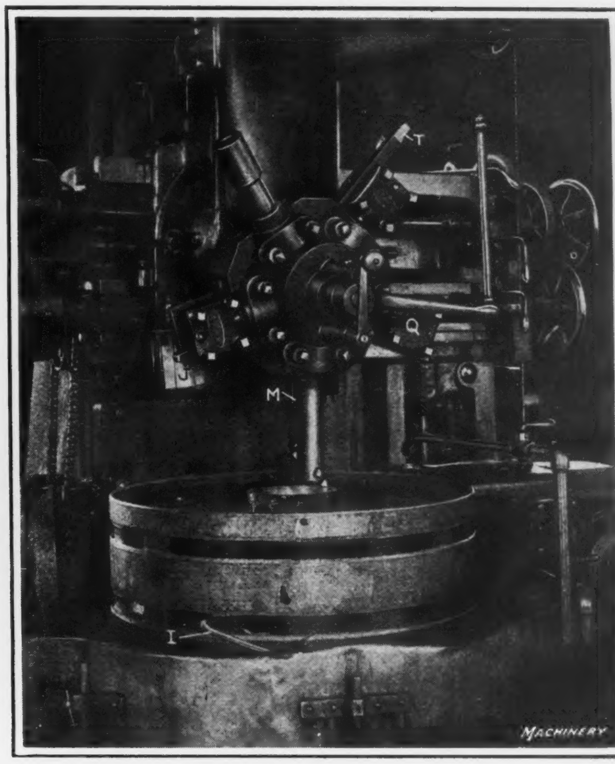


Fig. 11. Vertical Turret Lathe equipped for performing Second Sequence of Operations on Packard Five-ton Truck Wheels

assumes a position relative to two graduation marks which show whether the circumference is within the specified limits of tolerance. The importance of using a circumference gage of this type in place of a caliper for measuring the diameter is that in the event of the diameter varying slightly from point to point, there may be trouble in getting the tire rim over the wheel, but with a gage of this type, which actually measures the circumference, such trouble is not so likely to be encountered. After the side-head has started on its finishing cut, the turret is indexed to the third face to bring into operation a tool carrying three cutter-bits that is employed for boring diameters *F*, *G*, and *H* in the hub. A similar tool on the fourth turret face finish-bores the same diameters, and on the fifth face of the turret there are tools for reaming these holes. For this sequence of operations the total machining time is two hours.

Second and Third Settings of the Work

Fig. 11 shows one of the Packard five-ton wheels set up on a Bullard vertical turret lathe for the second sequence of operations. The machine used for this purpose does not employ any tools mounted on the side-head and it is provided with a fixture on which the work is centered by a pilot entering the finished bore of the hub. The work is clamped down on leveling blocks and driven by means of a hook *I*, one end of which enters a T-slot in the table, while the other end engages one of the openings in the work. While mounted on this machine, the tool *J* on the first face

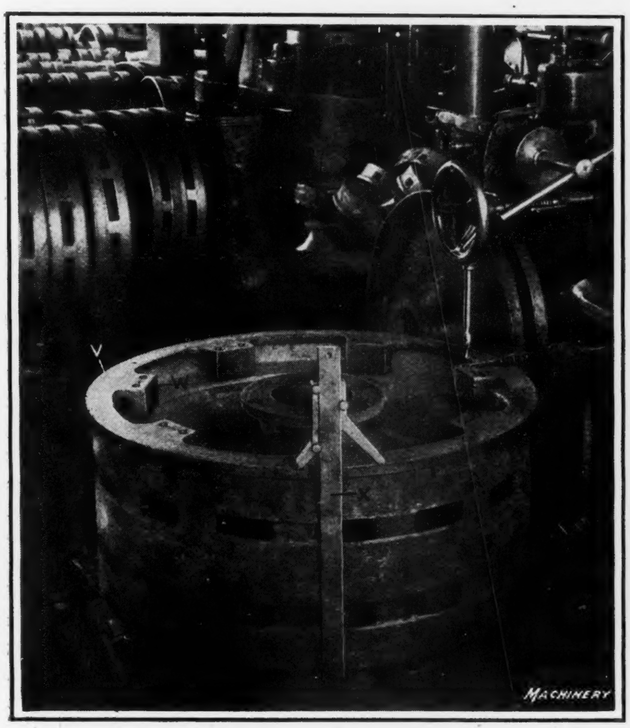


Fig. 12. Vertical Drilling Machine for drilling Holes at Opposite Side of Wheel in Accurate Alignment

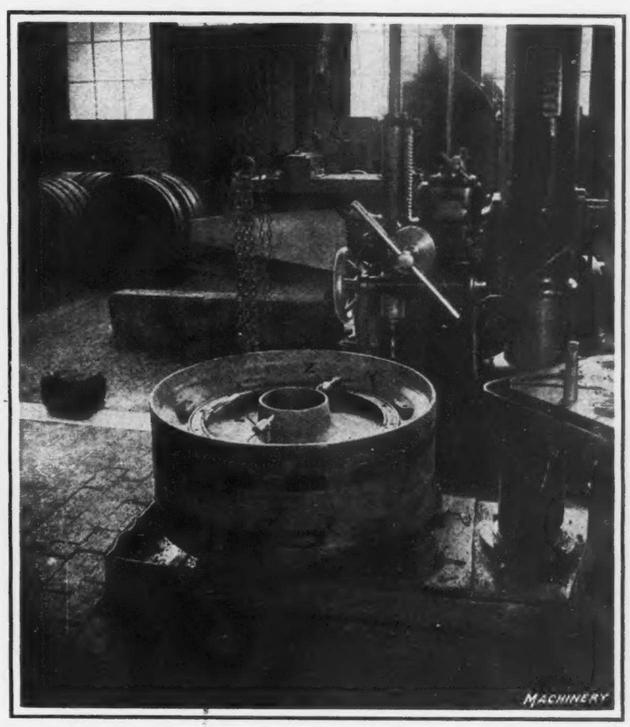


Fig. 13. Vertical Drilling Machine equipped for drilling and tapping Twelve Holes in Brake-drum Seat

of the turret faces edge K of the rim, and the same tool takes a second cut over this surface for finishing. Following the same procedure that was employed at the first setting of the work, the turret is then lowered 1/8 inch to bring tool J down into position to take a roughing and a finishing cut over the surface L of the hub. On the second turret face there is a tool M that provides for rough-boring diameters N, O, and P to within 1/16 inch of the required size. After this cut has been taken, the turret is indexed to bring into action a tool Q that faces the chain hook lugs R, a roughing and finishing cut being taken over these surfaces. On the next turret face, a tool T is provided for boring and facing the brake-ring fit S, 1/16 inch also being allowed on these surfaces for subsequent finishing. The machining time required to complete the second sequence of operations is fifty minutes.

For performing the third sequence of operations on these five-ton truck wheels, the work is mounted as it is shown on the vertical turret lathe that is illustrated in Fig. 11, except that a four point expanding plug is used to center the work accurately from the finished bore in the hub. While set up in this manner, a finishing cut is taken in holes N, O, and P and on the brake-ring fit S to provide for bringing the hub diameters within limits of ± 0.001 inch and the horizontal surface of the brake-ring fit S within ± 0.0025 inch from the level of surface L of the hub. For the finishing operation on the brake-ring fit S, a tool is employed that is similar to the tool T used at the second setting of the work, but for finishing diameters N, O, and P a boring tool and a reamer are used successively. On this job the production time is forty-five minutes. This makes the total machining time for the three sequences of operations performed on these castings three hours and thirty-five minutes.

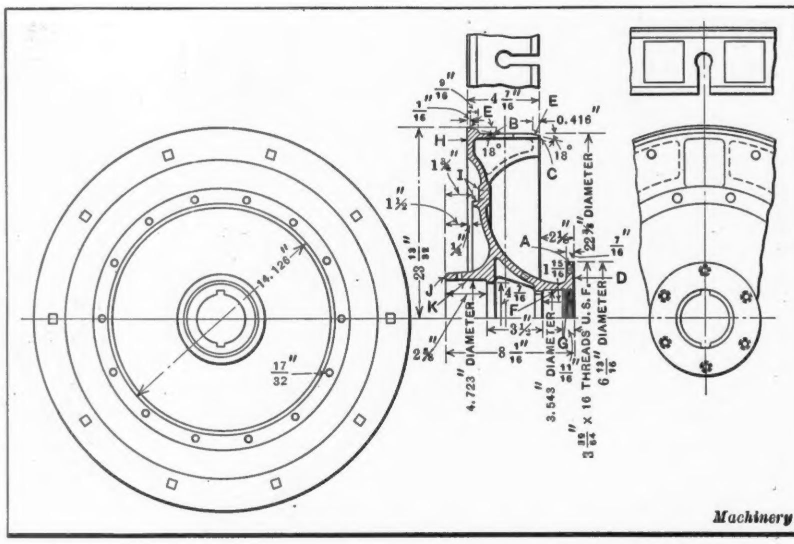


Fig. 14. Side and Cross-sectional Views of Clark Two-ton Pneumatic Tire Wheel for Use on Clark Rear Axle

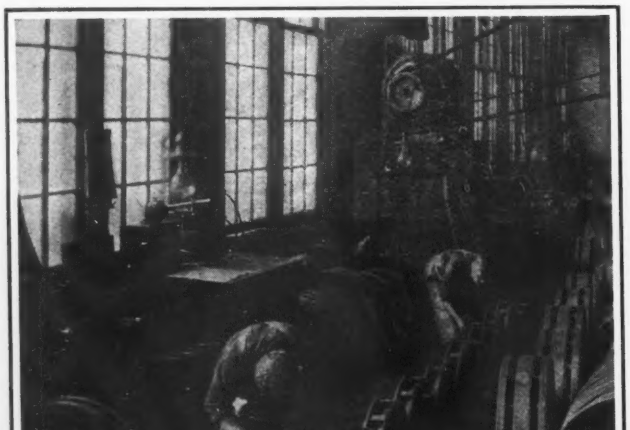


Fig. 15. View of the Department of the Wheel Shop in which Inspections are conducted

Drilling Two Holes in Each Chain Hook Lug

It will be apparent from Fig. 9 that it is necessary to drill two 9/16-inch holes in each of the chain hook lugs R and E at opposite sides of the work, and these holes must be in accurate alignment. To provide for the performance of this operation, a Cincinnati-Bickford single-spindle upright drilling machine is employed, as illustrated in Fig. 12. The work-holding fixture employed for this purpose is of quite simple design, consisting of a pilot over which the work is dropped by means of a chain hoist, and roller supports to facilitate the movement of the work to bring successive chain hook lugs in position for drilling. Reference to Fig. 12 will make it apparent that quite a simple drilling jig is employed for this job, consisting of a ring V that fits over the finished outside diameter of the work and is provided with projections W that extend inward over each of the chain hook lugs and are provided with two bushings for guiding the drills. It is very important to have the holes drilled in lugs E and R, at opposite sides of the work, in accurate alignment, and for that purpose use is made of a square X that is used to scribe a line down the side of the work to form the continuation of a setting line provided on the edge of the drill jig V. By setting the index mark on the drill jig on this line for drilling the holes in one side of the work, and then setting it on the same line for drilling the holes on the opposite side of the casting, assurance is obtained that the two sets of holes will be accurately in line with each other. On this job the rate of production is three completely drilled castings per hour, and owing to the weight of the castings, part of this time is consumed in setting the work up and removing it from the machine.

Drilling and Tapping Holes in Brake-ring Fit

It still remains to drill and tap twelve 1/2- by 18-inch holes U in the brake-ring fit S, Fig. 9, and for the performance of this operation another Cincinnati-Bickford drilling machine is employed, that is equipped with quite a similar jig to the one just described for producing the holes in the chain hook lugs. The ring jig used for locating these holes is shown in place at Y on the machine in Fig. 13, where it will be seen to consist of a ring, the outside diameter of which is turned to locate inside of the machined fit for the brake ring. There is the usual arrangement of drill bushings around this ring to provide for drilling the holes in the proper locations, and toggles Z are pushed downward so that their inner ends grip the hub of the wheel and prevent the jig from shifting its position. As in the previous case, the work is rotated on the fixture by turning it on a central pilot that enters the bore in the hub. After the holes have all been drilled, the jig is removed and a tap is substituted in the drilling ma-

chine spindle to provide for cutting the threads. For drilling and tapping these holes in the brake-ring fit, the rate of production attained is 3½ castings per hour. Certain other minor operations still have to be performed on these truck wheels before they are ready for shipment, but there are no points of especial mechanical interest connected with this work.

Machining Operations on Clark Pneumatic Tire Wheels

In Fig. 14 there is illustrated a pneumatic tire truck wheel which was especially designed for use in connection with the two-ton rear axle manufactured by the Clark Equipment Co. The first sequence of machining operations on the castings for these wheels is performed on Bullard vertical turret lathes with the work held in a four-jaw chuck gripping the outside diameter at *E*, with the hub *A* at the top. A side-head on the machine rough-turns the outside diameter *B*, and at the same time a tool on the first face of the turret commences operating on face *C* of the rim. When this surface has been rough-faced, the same tool is employed to take a finishing cut; and after this operation has been completed, the same tool is raised through a distance of 2⅛ inches to provide for taking a roughing and a finishing cut over surface *D* on the hub. On the second face of the turret tool-post on the side-head there is a formed tool which provides for beveling the top surface *E* that constitutes a fit for the tire rim. After this operation has been completed, the main turret is indexed to bring a boring tool into operation for taking a roughing cut in hole *F*, and after again indexing the turret a finishing cut is taken in the same opening in the work. The fourth turret face carries a reamer for finishing hole *F*, and on the next two turret faces, tools are provided for cutting a relief for thread *G* and for cutting the thread, respectively. On this series of operations the production time is 1.6 wheels per hour.

Second Setting of the Work

The Bullard vertical turret lathe on which the second sequence of operations is performed on these castings is equipped with a solid center plug, over which the work is dropped and clamped down on height blocks. The drive is accomplished by means of a hook of the same general type as that shown at *I* in Fig. 11. On the side-head of this machine there is a tool that rough-turns the outside diameter *E*, and after this cut has been taken the side-head is indexed to bring a formed tool into the operating position to take a finishing cut over the beveled face *E*. On the first face of the turret there is a tool used for facing surface *H*, and after this cut has been completed the turret is dropped to enable the same tool to take a roughing cut over the gear-ring fit *I*; then the turret is raised to bring the tool into position to rough-face the top surface *J* of the hub. The same tool is next employed to take a finishing cut over surface *J*. Next, the turret is indexed to provide for taking a finishing cut over surfaces *I* of the gear-ring fit, and after this has been done indexing of the turret brings a tool into position for rough-boring the hub at *K*. On the next turret face there is a tool for finishing bore *K*, and after this cut has been taken the turret is again indexed to bring a reamer into operation in the same bore. On this job 1.2 castings are produced per hour. Aside from the boring mill work, there is nothing of unusual interest in the machining of these castings, the drilling operations being similar to the work done on wheels for the Nash "Quad" truck.

Methods of Conducting Inspection Work

After the machining operations have been completed on a set of wheel castings, they are transferred to a portion of the shop that is devoted to the work done by men who are specialists in inspecting. As shown in Fig. 15, it is the practice to set the castings up in a long row so that the men can walk from casting to casting, using the same gage to test the accuracy of a single dimension of the work. Then after this test has been conducted on all of the pieces, the inspector goes back to the starting point and exchanges the gage which he has been using for the one that will be employed in conducting the next test. By following this method of procedure, the inspections may be conducted very rapidly. It is the care that is taken in conducting inspection work, after every precaution has been taken in performing machining operations, that enables a product to win and hold its reputation.

* * *

CALCULATION OF DIAMETRAL PITCH AND FACE WIDTH OF PINIONS

By HUGH BOW

The following simplified method of finding the pitch and face width of pinions is based on the formulas given on page 597 of MACHINERY'S HANDBOOK. The application of the simplified method is shown by the solution of the problem given on page 596 of the HANDBOOK. In this example the load W at the pitch line is 420 pounds and the velocity V is 786 feet per minute. The allowable unit stress S for the material at the given velocity is 8660 pounds per square inch, and the pitch diameter of the pinion is 4 inches. In using the simplified method for finding the pitch, the outline factor Y in this case is taken as 0.266, this factor being the average of the factors for gears having from 12 to 30 teeth, as given in the table of outline factors on page 595 of MACHINERY'S HANDBOOK.

The width of face A in inches based on the velocity is given by the formula

$$A = \frac{(0.15\sqrt{V}) + 9}{P}$$

in which P = the diametral pitch.

Hence,

$$P = \frac{(0.15\sqrt{V}) + 9}{A}$$

But

$$P \doteq \frac{SAY}{W}$$

Therefore:

$$P = \sqrt{\frac{(0.15\sqrt{V}) + 9}{A} \times \frac{SAY}{W}} =$$

$$\sqrt{\frac{[(0.15\sqrt{V}) + 9] \times SY}{W}}$$

Substituting the values in the given example,

$$P = \sqrt{\frac{[(0.15\sqrt{786}) + 9] \times 8660 \times 0.266}{420}}$$

$P = 8.41$, or say 9 diametral pitch

The number of teeth would therefore be $9 \times 4 = 36$, and the outline factor Y for a gear having thirty-six teeth is found in the table to be 0.332.

The formula for the width of face is:

$$A = \tfrac{1}{2}\left[\frac{(0.15\sqrt{V}) + 9}{P} + \frac{WP}{SY}\right]$$

Therefore the width of face should be

$$A = \tfrac{1}{2}\left[\frac{13.2}{9} + \frac{420 \times 9}{8660 \times 0.332}\right] = 1.39 \text{ inches, say } 1\tfrac{3}{8} \text{ inches}$$

From this it will be seen that the width of face can be found without making repeated trials to determine the correct diametral pitch.

* * *

The painting of ladders is forbidden in the works of the General Electric Co. at West Lynn, Mass., on account of imperfections, such as knots, in the wooden members being hidden by the coating of paint. This rule is made to prevent accidents resulting from the use of ladders which are unsafe.

Reducing Cost of Locomotive Repair Work

AT the convention of the International Railway General Foreman's Association in Chicago, September 7 to 10, factors affecting the cost of repairing locomotives and cars were considered. Prior to the general discussion, a paper was presented dealing with the reduction of the cost of repairing cars and locomotives. The following abstract covers the more important points referred to.

In handling cars and locomotives economically, so as to effect a reduction in the cost of their repairs, careful well-trained supervision is essential. The supervisors should have executive ability; they should also have the gift of handling men properly, and be interested in their men. They should be broad-minded enough to be above petty envy and jealousy. Human nature should be their hobby. Supervisors who have had the opportunity of obtaining a schooling in different departments or who have had experience in different shops, are fortunate, as such knowledge is of benefit in their work.

In order to have an efficient, energetic, and interested shop organization, it is necessary to have the cooperation of all members of the executive staff. To increase this spirit, it is advisable to have weekly shop staff meetings to discuss the welfare of the shop. At these meetings the shop superintendent or general foreman can come into personal contact with the organization and get an idea of the condition of each department by the reports that the various foremen turn in. This enables him to make any changes he deems necessary to increase the production of the shop. At these meetings, subjects may be brought up for general discussion, such as general shop conditions or methods to be adopted to shorten the time of machine or erecting shop operations. An efficient organization member will see that each man under his charge is supplied with the proper tools and materials for his work, thereby reducing the cost of an operation to a minimum.

Roundhouse Repairs and Repair Shop Schedule

The roundhouse should make minor repairs on locomotives, such as require only a short time and a small amount of material, but which may cause damage that ultimately would necessitate more costly repairs if neglected. When locomotives are properly looked after in roundhouses, trips to repair shops become less frequent. There should be a first-class shop schedule or plan in the repair shop for doing the work with the facilities at hand. One system that is giving satisfaction is to have a general shop inspector take charge of the scheduling of locomotives through the shop, under the direction of the general foreman. A meeting is held three times a week with the shop staff organization at which each locomotive is scheduled and marked on a master scheduling board.

This information is transferred the next morning to small boards located with each gang of workmen by the schedule foreman, who also checks up each department and ascertains the cause of all delays, reporting to the general foreman. On the shop boards all schedule dates are marked in white chalk. If the work on any part is completed on or before time, it is marked in blue chalk, and if it is not up to schedule, in red chalk. This scheme has a tendency to create competition between the workmen, as one group does not like to see another surpass it, and so work is finished with greater dispatch and costs are considerably reduced.

Machinery and Facilities

When it is possible to replace old machines or appliances with new ones, this should be done immediately, but when this is not possible, the best must be made of the situation. More money is wasted through the use of old and obsolete machinery in making repairs to locomotives, than from any other cause. During the last few years, locomotives have been rapidly growing in size and weight, but in many cases repair shops have not kept pace with them, and the result has been a high cost of repair.

Another means by which the cost of repairs may be materially reduced in the machine shops, is by the use of jigs, chucks, dies, box-tools, pneumatic clamps, gang tools, templets, expanding mandrels, etc., all of which reduce the cost of machine operation. In the erecting shops, power-driven valve-setting rollers, motor-driven valve-pulling bars, motor-driven flue cutters and flue rollers, and motor-driven chucks for grinding steam pipe rings and superheater units, have been found to reduce the cost of repairs greatly by reducing the time consumed in performing the operations.

All work going through the shops should be properly routed, thereby doing away with unnecessary handling, and resulting in a saving of time and money. For example, all connecting-rod work should be confined to one portion of a shop with a rod rack, drilling machine, power press, and lathe in close proximity to each other so that no time is lost between the various operations performed on the different machines. As another example, the equipment used in producing driving-boxes such as a power press, brass crucible for pouring hub liners, planer, boring mill, lathe, and shaper, should all be placed within a radius of ten or twelve feet, so that when a driving-box enters within the circle, it is not necessary for it to leave the circle until it is finished and ready for application.

Material and Labor

In some railroad shops, little attention is given to the method of handling material. A high-priced mechanic may be seen pushing a truck from the store-room with a load of material on which he is about to perform some work. Such trucks should obviously be taken care of by a trucker or laborer, thereby saving the difference between the wages of the two men, and at the same time permitting the mechanic to be used on production work. Every effort should be made to have material placed in well-regulated store-rooms, so that when men are sent for certain articles they need not waste time in looking for them.

Every employe should be imbued with the thought of reducing all unnecessary expenses. Many men are inclined to be careless about the use of material; consequently, much of it is wasted unless a strict check is kept. Again, men often attempt to get new material rather than use second-hand parts when the latter are just as good as new ones for the purpose. In order to make men think along the right lines, some roads hold monthly efficiency meetings in the office of the master mechanic, between representatives of the shop crafts and members of the executive staff, at which the subjects of shop repairs, use of material, and the elimination of waste are discussed. These men take part in the discussion and advance many ideas which, when applied, save time and material. Then, once in eight or ten weeks, a mass meeting is called in the shop thirty minutes before quitting time, at which the men are addressed by some member of the staff and a representative of the employes, who bring before them the necessity of conserving material and thereby causing a reduction in the cost of repairs.

Another manner in which the shop organization can keep the cost of repairs low is to insist upon each man doing the work thoroughly instead of accepting defective work which is sometimes done because the locomotive is wanted in a

hurry. This is a poor method to follow and an expensive measure, because it is usually not long before the job must be done again at an additional expense.

Application of Welding Processes in Repair Work

A great saving of material is effected by the use of the electric welding process. Locomotive parts that formerly had to be scrapped on account of wear, such as guide bars, brake-beam ends, brake-hanger pins, radius-bar ends, forked ends of eccentric rods that have become too wide for the link, and driving-boxes that have been worn down on the shoe and wedge faces are now built up by the use of this process and made almost as good as new. In boiler departments, oxy-acetylene welding is used quite extensively in welding flues, flue sheets, side sheets, and patches, thereby effecting a saving over the old method in which the parts were attached with rivets. The cutting torch is also useful in locomotive departments; however, the cutting of holes should be avoided, as the irregular surfaces of such holes start cracks and result in the failure of parts. The patching of fireboxes by either process of welding eliminates the frequent recalking of riveted joints.

A system of careful inspection should be enforced to insure that engines and cars are thoroughly examined to find any defects that may result in the failure or rapid deterioration of parts if not given prompt attention. Engines should be kept clean, as both engine and shop men take more interest in them then. Shops and premises should also be kept clean, and all refuse and material picked up. This is an important proposition and increases the morale of the men.

* * *

SUITABLE STEELS FOR AUTOMOBILE PARTS

Steels suitable for automobile parts were specified by Dr. W. H. Hatfield of the Brown-Firth Research Laboratory, Sheffield, England, in a paper recently read at a meeting of the Institution of Automobile Engineers, London. The materials and the parts for which each is suited are given in the following list:

Air-hardening Nickel-chromium Steel—Connecting-rods, transmission gears and steering worms, pinions and pivots.

Aluminum Alloys—Cylinders, pistons, crankcases, gear-boxes, axle-casings and differential casings.

Bright Drawn Mild Steel—All nuts.

Casehardening Carbon Steel—Ball races.

Cast Iron—Water-cooled cylinders, cylinder-liners, valve-guides, valve-seats, water-jackets, pistons, piston-rings and inlet and exhaust pipes, including manifolds.

0.9 Per Cent Carbon Steel—Clutch-plates and keys.

0.40 Per Cent Carbon Steel—Internal and external cone-clutches and rear-axle housings.

Chromium-vanadium Steel—Valves, clutch and chassis springs.

High-carbon Chromium Steel—Ball bearings.

Malleable Iron—Inlet and exhaust pipes, including manifolds.

3 Per Cent Nickel Steel—Steering-arm levers, arms and rods, tubular steering columns, steering swivel forks, chassis frames, front and rear axles, and torque tubes.

5 Per Cent Nickel Casehardening Steel—Piston-pins, valve cams, camshafts, tappets, timing wheels, differential spiders, gear-box shafts, and transmission worms and worm-shafts;

3 Per Cent Nickel-chromium Steel—Connecting-rods, crank-shafts, and clutch-shafts

Phosphor Bronze—Worm-wheels.

Silico-manganese Steel—Valves, rotary pump gears and wire spokes.

Steel Castings—Cylinders, brake-drums, shoes, thrust and clutch withdrawal collars, differential gear-boxes, and spring shackles

Pressed Steel—Axle castings and differential casings.

CONSTITUENTS AND CHARACTERISTICS OF RUSTLESS STEEL

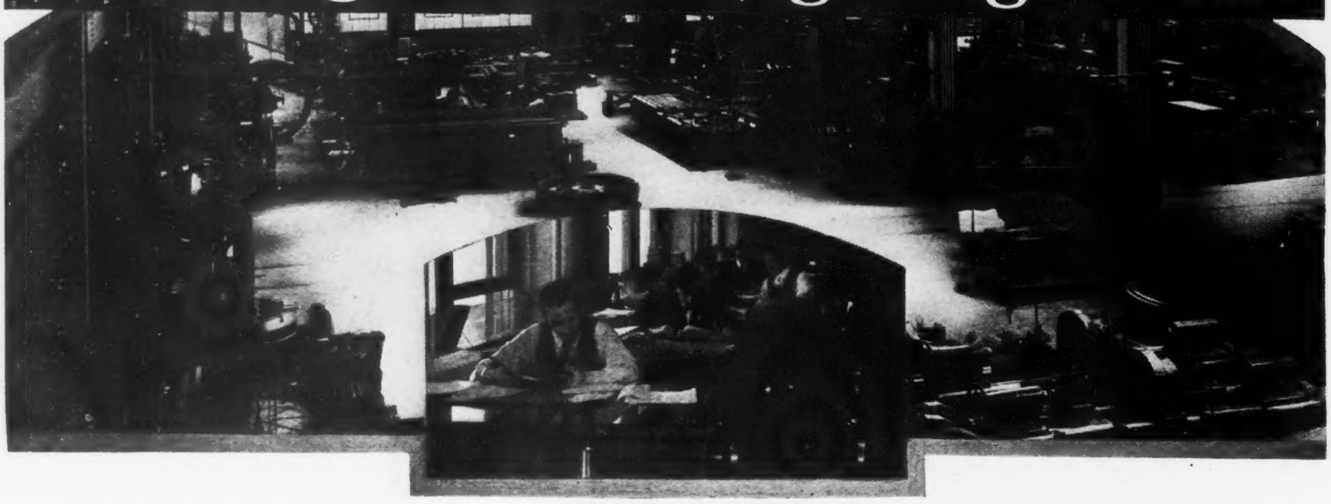
In a paper presented before the Engineers' Society of Western Pennsylvania, Elwood Haynes, president of the Haynes Automobile Co., Kokomo, Ind., stated that stainless or rustless steel consists essentially of an alloy of iron and chromium containing usually from 0.1 to 1 per cent of carbon, although the latter element may be present up to nearly 2 per cent without seriously impairing the working qualities of the steel. Owing to the high percentage of chromium and its tendency to oxidize at the melting point, even in the presence of carbon, it has been found advisable to melt the steel either in crucibles or the electric furnace. After melting, the metal can be poured into ingot molds in the usual manner and the ingots thus obtained can be forged or rolled into bars or sheets. If the ingots are of comparatively small size, they will be found to be very hard after casting, especially if they have been stripped hot and allowed to cool rather rapidly in the air. Indeed, small bars thus produced are likely to be almost file-hard.

If a small piece of steel thus produced is placed in a beaker with a piece of ordinary steel and covered with nitric acid, the ordinary steel will be dissolved with great violence, while the chromium steel will remain utterly unchanged, thus proving that its immune qualities are primarily due to its composition. This is true whether the steel contains large or only minute quantities of carbon. Cold chisels cast in iron or graphite ingot molds are sufficiently hard without tempering to cut ordinary iron or steel. By heating cast bars to a bright orange temperature, they can be forged fairly readily into various forms. After the forging is completed, the metal can be allowed to cool in the air, and will be found to possess a remarkably fine grain and good cutting qualities. Quenching in water enhances the hardness to a considerable degree, particularly if the steel contains more than 0.4 per cent of carbon. It is best, however, to use oil for quenching, to avoid local contraction stress in the finished article which might cause it to break under slight shock or jar.

Notwithstanding the comparatively high temperature at which this steel is worked, the bars show almost no scale during the forging operation. When finished, they are covered with a blue-black skin consisting of a thin film of oxide. Owing to the absence of deep oxidation and resistance to deformation at comparatively high temperatures, the alloy is admirably suited for casting engine valves, distilling apparatus and many other purposes of a similar nature. When ground and polished, the alloy resists tarnish to a remarkable degree. It is superior in this respect to brass, copper and nickel-plate, and far superior to any other steel yet produced. Axes, hatchets, saws, and chisels made from it will not rust in the atmosphere nor when exposed to salt air or salt water. The alloy will no doubt find a large use in the manufacture of propeller blades for steamers, since its modulus of elasticity is much higher than that of bronze and it resists the action of both fresh and salt water perfectly.

Its great strength and comparatively high elastic limit are likewise in its favor. It should have a large application in the manufacture of pump rods, cylinder linings, pump valves, and the like. The alloy is attacked slowly by dilute or strong sulphuric acid and also by hydrochloric acid, but nitric acid has little or no effect upon the polished surface of the metal. It is likewise unaffected, when properly made, by practically all the fruit acids, including strong vinegar. The alloy should also fill a long-felt want among carpenters and others using wood-cutting tools. Its freedom from rust, together with its capability of taking a keen cutting edge, renders it admirably suitable for tools of this nature. When made into auger bits, it has remained bright after having been used for years and subjected to all sorts of atmospheric influences.

Handling and Routing Large Work



Methods Employed by Manning, Maxwell & Moore, Inc., in the Putnam Machine Works, Fitchburg, Mass., for the Routing of Work through the Factory

THE advantages gained by systematic arrangement in a factory, and by following a pre-arranged schedule when machining work, are many. In large factories, where the product consists of many heavy parts, certain methods must be followed which are not always necessary in shops where the output consists of machines made up of many small or medium-sized members. Not only must the handling of equipment for the large castings and steel parts be different, but the planning must be more detailed. This will be appreciated when it is remembered that orders for heavy machinery seldom consist of more than fifty machines—usually less—so that it becomes necessary in the production work to make frequent change-overs in the machining of small lots. In order to obviate the possibility of the machine tools being idle through failure to schedule the work to them, a carefully laid out routing system and time schedule should be employed.

At the Putnam Machine Works of Manning, Maxwell & Moore, Inc., Fitchburg, Mass., the product consists largely of machine tools, such as car-wheel lathes and boring machines, the base castings of which generally weigh from fifteen to twenty tons. Some idea of the size and nature of the heavy castings used on these machines may be had by referring to Fig. 1, which shows the mold for a 54-inch car-wheel lathe base. The making of this mold and the setting of the cores required the services of four men and two helpers for a period of eight days. The length of the mold is 23½ feet and the width 6 feet, and the casting produced from it weighs 15 tons.

The system employed in the handling and routing of such parts is as carefully planned as that used in the operation and scheduling of a railroad. From the time the work enters the factory, either from the foundry or from the stock cars, it travels in a continuous course up one side of the shop, and when completed is transferred on flat cars to the opposite side to be assembled and returned to storage space. In this way, there is a steady flow of work on the manufacturing side of the shop which is not interfered with by congestion, since all the assembling, storing, and shipping of finished machines is done on the opposite side of the shop. The routing system is analogous to the time-table of a railroad, and means are provided to keep the passageways clear and the work moving to the scheduled departments and specially designated machines, in proper sequence and according to established time.

Arrangements of Facilities for Handling Work

There are tracks leading to the foundry and freight cars at one end of the shop, the tracks to the foundry being shown in Fig. 2. Flat cars are used for transporting the material, from which it is removed and stored or placed in readiness to start the machining operations. For the heavy

Fig. 1. Mold for 54-inch Car-wheel Lathe Base

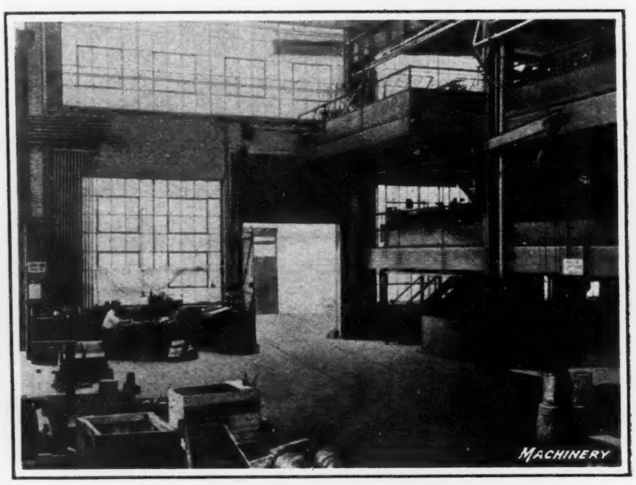


Fig. 2. Receiving Department of the Plant

castings, use is made of wall hoists and overhead cranes to move the work toward the opposite end of the shop as the various machining operations are performed. One of the wall hoists is shown in the illustration, as well as the platform and track for the overhead crane. A Shaw electric crane, of twenty tons capacity, running the entire length of the shop, and a number of Sprague electric wall hoists of one-ton capacity are used. It will be seen that there is a storage room at the right for rough castings which are small enough to be taken care of in this manner. This end of the shop contains the receiving department so that as the material arrives it can be readily recorded. The records of all material carried in stock are kept in the storage record department which is located in the lower gallery, as illustrated.

Reference to Fig. 3 will give a general idea of the arrangement of the shop as well as the gallery at the right, which contains the smaller machine tools and tool-room. Attention is also directed to the cross tracks, which are laid at regular intervals from one side of the shop to the other, and which carry flat cars that deposit the finished work on the opposite side of the shop preparatory to assembling.

Preparations for Starting an Order

When an order for a number of machines is received, the authority for starting the manufacture of parts required for the order is given to the planning department by the general manager. The first step taken by the planning department is to obtain promises of blueprints and material lists from the engineering department. These material lists contain all the parts needed to complete the order, grouped by materials, as well as all information necessary to order the material and start the actual manufacture of the work. The material lists are made up in forms, a number of which are bound together to constitute the entire bill of materials for the order.

Upon receipt of the material list in the store-room, the proper entries are made on the material list for ordering parts from storage, and the necessary raw material for filling the order. The quantity of the finished and rough parts on hand determines the number to be manufactured on each order. For example, if the material list specifies six machines, each machine requiring six castings of a kind, thirty-six such parts are required to build the six machines on

Fig. 3. General View of the Production Side of the Shop showing a Wall Hoist and Cross Tracks extending across the Shop. Note the Amount of Available Floor Space for Passageways, and the Gallery in which the Small Machine Tool Department and Tool-room are located

For boring, reaming, and facing operations on the heavy base castings, portable machines are used, these jobs being set up on floor platens, one of which may be seen in the center of Fig. 3. This illustration also shows the freedom from congestion and the amount of available floor space for transporting the work which the general arrangement affords. The high bay furnishes ample space for overhead crane installation, and also provides good ventilation and excellent lighting conditions.

Having stated in a general way the nature of the work and the method of handling, it will be apparent that failure to deliver the work promptly to the machine on which it is to be finished, would result in a serious loss of time, and would also produce a considerable amount of confusion. To this end the scheduling and routing of the work has been worked out to a very fine degree, and, though of necessity somewhat involved, it is stated that the exact location and state of completion of each part in process of manufacture can be readily determined at any time from the planning department records. In order that the system may be fully understood, the details pertaining directly to the manufacturing operations will be mentioned and the methods of recording and following the progress of the work described.

this order; but if the store records show a balance of four rough and two finished castings on hand, the storekeeper will enter on the material list the information which will result in thirty new castings being ordered, and thirty-four (including the new castings and the four rough ones on hand) being sent through the shop on a machining order. The list is then delivered to the order department, from where any order for purchasing material not already in stock, is issued. The store card upon which the record of parts or rough stock on hand is kept in the storehouse is shown in Fig. 4. It contains the balance carried over from each preceding order, and the location of the bin in the storehouse in which the stock parts are carried, as well as all other necessary data regarding the piece being ordered.

When the planning department receives the blueprint and the material list containing all the information regarding name, material, and number of the part, as well as the drawing number and pattern number or stock size, the actual scheduling of the work is started. First, the necessary casting orders (see Fig. 6) are issued. These are made out on three cards of different colors, one being delivered to the foundry, one to the pattern shop, and one to the core-room. The stores requisition for material slip, shown in

SIZE AND DESCRIPTION		PART NUMBER		MAX.	STORE	PAGE
	AVG. WT.	PATTERN NUMBER		MIN.	BIN	BIN
		DRAWING NUMBER		UNIT	BIN	ACC'T NO.

ORDERED					RECEIVED				APPROPRIATED					Balance Available	ISSUED			BAL.
DATE	ORDER NO.	QUAN.	BAL. DUE	√	DATE	ORDER NO.	QUAN	√	DATE	ORDER NO.	QUAN.	BAL. DUE	√	=	DATE	ORDER NO.	QUAN.	ON HAND

Fig. 4. Card used for recording Stock carried in the Storage Room

Fig. 7, is issued in duplicate, the original in white, and the carbon copy in green, both of which accompany the material as far as the department in which the first machining operation is performed. At that time the green copy is delivered to the planning department, where it serves as a formal notice that the production is about to start, and is the first marker for recording the progress of the work. The original slip, at the same time, is sent to the store-keeper.

In filling out the operation order slips, one of which is shown in Fig. 8, reference is made to a work schedule for each machine or type of machine in the department through which the material is to pass in the process of manufacture. Every machine in the shop is numbered and grouped, and the work schedule for a specified department governs the sequence in which the various parts are to be machined on any particular equipment. If the department contain a number of standard machines, it is not necessary to designate by both name and number the exact machine upon which the work is to be performed, but in the case of special machines, of which there is but one of a kind in the department, a schedule for the individual machine is made out containing the order number, the number of pieces, the name and number of the part, as well as the number of hours allotted for the completion of the work, and the dates of entering and leaving the department. This information is arranged in the form shown in Fig. 5, from which the availability of any machine for the performance of the work being routed may be readily determined.

LARGE LUCAS MILL # 317 Sheet # 4

Kindly arrange to work in sequence given as near as possible

Order No.	Pcs.	Part Name	Part No.	Time	In	Out
865	12	R. H. Apron	4LG-50-A55	90:00	9-22	10-5
865	12	L. H. Apron	4LG-50-A56	90:00	10-5	10-19
860	3	Apron Plates	LL-50-A6	135:00	10-19	11-8
860	3	Gear Boxes	LL-70-A7	31:00	11-8	11-12
860	3	Compounds		30:00	11-12	11-17
860	3	Carriages	LL-30-A1	29:00	11-17	11-20
860	3	Yoke	LL-160-A2	3:00	11-20	11-22
860	3	Sleeve Gear	LL-70-B6	10:00	11-22	11-24
860	3	Change Control Rockers	LL-70-A4	10:00	11-24	11-26
860	3	Gear Guard on end of Head	LL-71-A2	8:00	11-26	11-27
860	3	Set over nut	2LM-20-A4	5:00	11-27	11-28
860	3	Rack Pinion Bracket	LL-70-A7	3:00	11-28	11-28

Fig. 5. Schedule which is kept for All Groups of Machines, furnishing the Dates on which the Work is delivered to and from the Machine

In addition to the schedule of work for each machine, a standard operation sheet, such as shown in Fig. 10, is employed to aid in filling out the operation order slip. These operation sheets specify the sequence of operations, the numbers of the departments in which the work is to be performed, the number of the machine to be employed, and the time allowance. It will be seen that Operation 4 is performed in department No. 40, but that no machine is specified, this being due to the fact that there is but one machine in this department suitable for performing the work required for this operation. The time required for this operation has not been established, and until this has been done no time entry can be made. It may be mentioned here, however, that an estimated time is carried on the cost sheets, which, when verified by average performances, will be duly carried on the operation sheet.

ORDER NO.	PART NAME	DRAW'G NO.	PART NO.	PAT. & MATERIAL	NO. PIECES CAST	MACH
800AP2	Bevel Gear Pinion Stand	LA-22	5773	CI	12	
PAGE / ITEM	DATE OF ORDER 7-14-20 CASTING ORDER				P. M. CO. 158 AV. WT.	

DATE													
MOULDER'S NO.													
NO. MADE													
NO. LOST													
NO. DELIVERED													
DATE													
MOULDER'S NO.													
NO. MADE													
NO. LOST													
NO. DELIVERED													

Fig. 6. Casting Order issued immediately upon Receipt of the List of Materials

STORES REQUISITION

ORDER NO.	LOT NO.	Stores No. 5K9A Req. No. 86852 A			PART NO.
800AP2					5773
REF'D. MAT'L. REPORT NO.	FOREMAN'S ORDER NO.	Del. to Dept.	MACH. NO.	PATTERN NO.	DRAWING NO.
		9	369		LA-22
USED FOR	(DESCRIPTION OF WORK)			MATERIAL SIZE	CHARGE ACCT.
				C.I.	

QUANTITY REQUIRED	DESCRIPTION	WEIGHT EACH	TOTAL WEIGHT	UNIT PRICE	VALUE
12	Bevel Gear Pinion Stand				

ORDERED BY	FILLED BY	RECEIVED BY	DATE RECEIVED	CREDIT ACCT. NO.	TOTAL

Issued in 2 copies; Orig. (White), Dup. (Green). White and Green copies to accompany Material and when signed for retain Green copy and return White copy to Storekeeper. FORM 523 M H. & M. INC

Fig. 7. Stores Requisition Slip issued to the Storage Room when entering a New Order

ORDER NO.	LOT NO.	OPERATION ORDER	PART NO.
800AP2		№ C40751	5773

REJ. MATL. REP. NO.	FOREMAN'S ORDER NO.	PATTERN NO.	DRAWING NO.
			LA-22

OPER. NO.	IN DEPT.	MACH. NO.	MOVE TO DEPT.	MOVE TO MACH.	QUANTITY ORDERED	GOOD PIECES	BAD PIECES	PIECE WORK TIME SET UP HRS.	SET UP MIN.	TIME EACH HRS.	TIME EACH MIN.	ESTIMATED TIME SET UP HRS.	MIN.	TIME EACH HRS.	MIN.
1	9	369	13	225	12				17		11.5				

DESCRIPTION: Bevel gear pinion stand CI 7-14-20

CHARGE ACCOUNT NO.

OPERATION: Bore, ream and face one end

MACHINE HOURS

CLOCK NUMBER	MACH. NUMBER	START	STOP	OVERTIME	ACTUAL HOURS	HOUR RATE	GOOD PIECES	D. ORDER CLASS	PCS.	HRS.	STD. TIME	PC. WORK VALUE	DY WORK VALUE	BONUS ½ OF GAIN	INST.

FOREMAN'S APPROVAL

D.-ORDER CLASSES: A - DEFECTIVE CASTING; B - DEF. WORK. PREV. OP.; C - DEF. WORK. PRES. OP.; D - ENGINEERING DEPT.

EXTENDED P.R. DEPT. | CHECKED P.R. DEPT. | ENTERED P.R. DEPT. | ENTERED COST DEPT.

Fig. 8. Operation Order Slip issued in Duplicate for Each Separate Operation

MOVE ORDER TO OPEN ORDER STORES — NO. MO 8951 A

INSPECTED BY	DELIVERED TO DEPT	FROM DEPT	ORDER NUMBERS
	5A26	30	800AP2
TO BE USED ON JOB NO.	DATE DELIVERED	LOCATION	

QUAN.	PART NUMBER	DESCRIPTION	COST EACH	VALUE
	5773	Bevel Gear Pinion Stand		
		7-14-20		

KIND OF MAT	TOTAL WGT	WGT EACH	PRICE PER LB.	MAT COST EACH	LABOR COST EA.	EXP COST EA.	%	TOTAL VALUE
C.I.								

RECEIVED BY | DATE RECEIVED | ENT STORES RECORD BY | ENT IN MAT LIST BY | FIGURED BY

Issued in two copies, original (Salmon), duplicate (Green), for all perfect work from process (except surplus parts) for open order stores. Allow both copies to accompany material to open order stores. When signed for forward Salmon copy to Main Office and Green copy to Planning Dept. FORM NO. 300 M M M INC P M WKS.

Fig. 9. Move Order Slip which authorizes Delivery of Finished Work to Storage

The final disposition of the bevel gear pinion stand for which this operation sheet is filled out, is department 5 A26, the storage-room from which material is drawn to fill a pending shipment.

Having determined upon the sequence of operations and the department and machine numbers, these data may then be entered on the operation order slip, together with the number of pieces required and the setting-up and machining time allowances. For each operation two of these operation order slips are made out, the slips for each preceding operation furnishing the number of the machine and department in which the next operation is to be performed, following the sequence shown in Fig. 10. The operation order shown in Fig. 8 illustrates the method of routing the work from one department to another. In the case shown, the work is routed from department No. 9 in which one end of the work is bored, reamed, and faced, to department No. 13, where according to operation sheet Fig. 10, the second operation is performed on machine No. 225. Operation orders for the third, fourth, and fifth operations would be made out in the same general way.

The move order, Fig. 9, is also made out by the planning department, and furnishes the authority to move the parts into what is known as "open order stores"; that is, they are placed in readiness to be shipped on the current order. The two copies each, of the stores requisition slip, the operation slip, and the move order slip are clipped together, so that as the work progresses these slips can be torn off without disturbing the others, until only the move order slips remain. In the present case, a bevel gear pinion stand, part No. 5773, is being machined, and there would therefore be fourteen slips accompanying the material at the start of the order. These, as well as the blueprint of the piece of work, are enclosed in an envelope, one side of which is shown in Fig. 11, so that all the information regarding machining and routing the work is kept intact. This envelope contains on the front a suitable record for identification of the job and instructions for following it up. On the reverse side of the envelope, space is provided for entering rejections, partial shipments, and the sequence of department numbers through which the work is scheduled to pass.

OPERATION SHEET SUPERSEDES SHEET DATED	NAME OF MACHINE	PATTERN NO.	PART NUMBER
	18" x 36" Gap. Lathe	LA - 66	5773
MATERIAL	DESCRIPTION		DRAWING NO.
C.I.	Bevel Gear Pinion Stand.		LA-22

OPER. NO.	IN DEPT.	MACH. NO.	OPERATION NAME	SET UP TIME HRS.	SET UP TIME MIN.	TIME EACH HRS.	TIME EACH MIN.
1	9	369	Bore, ream and face one end.		17		11.5
2	13	225	Mill bottom		30	0	.06
3	12	363	Counterface end, drill and spotface for securing screws and drill oil and pin holes.		20		16.5
4	40		Cut oil groove.				
5	30		Fill and paint.				
	5A26		Open Order stores.				

DATE ISSUED: 7-14-20. TOTALS

NO. CORRECTIONS ALLOWED ON THIS SHEET | APPROVED BY | CHECKED BY | GRAND TOTAL

Form 611 | DATE | DATE

Fig. 10. Operation Sheet on which Sequence of Operations, Order of Departments in which the Work is performed and Machine Numbers, Name of Operation, and Time Allowance are carried

The Dispatcher and his Duties

The passage of the work from department to department is directed by dispatchers. Dispatchers' offices, such as shown in Fig. 13, are located throughout the plant, there being one of these offices for every two or three departments, depending upon the number of machines and work capacity of the departments. When the work arrives at the first dispatcher's office, he detaches the stores requisition slips, Fig. 7, and the first two operation order slips for each operation to be performed in the departments under his jurisdiction. He then sends one stores requisition slip to the storekeeper and one to the planning department, and retains the operation orders in his office where they furnish the necessary reference for assigning work. The operation order slips are chronologically arranged for each machine, and

ORDER NO.	SHOP ORDER NO.	PART NAME	R.M.S. NO.	NO. PCS.
800AP2		Bevel Gear Pinion Stand		12

BAR STOCK QUANT.	MAT'L.	DRAWING NO.	PART NO.	PATTERN NO.	DATE
	CI	L4-22	5773		7-14-20

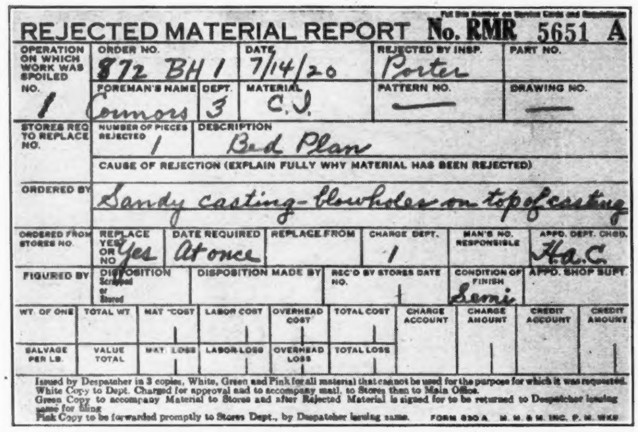
PRINT MUST FOLLOW THIS JOB

INSPECTOR

PRINT MUST FOLLOW PRODUCTION CARD AND FINISHED MOVE ORDER TO FINISHED STOCK ROOM

P. M. FORM 802 A

Fig. 11. The Envelope in which the Blueprint of the Work and the Operation Orders are enclosed carries Instructions for routing the Work through the Shop



REJECTED MATERIAL REPORT No. RMR 5651 A

OPERATION ON WHICH WORK WAS SPOILED NO. 1 — ORDER NO. 872 BH 1 — DATE 7/14/20 — REJECTED BY INSP. Porter — PART NO.

FOREMAN'S NAME Connors — DEPT. 3 — MATERIAL C.I. — PATTERN NO. — — DRAWING NO. —

STORES REQ TO REPLACE NO. — NUMBER OF PIECES REJECTED 1 — DESCRIPTION Bed Plan

CAUSE OF REJECTION (EXPLAIN FULLY WHY MATERIAL HAS BEEN REJECTED)

ORDERED BY — Sandy casting-blowholes on top of casting

ORDERED FROM STORES NO. — REPLACE YES OR NO Yes — DATE REQUIRED At once — REPLACE FROM — CHARGE DEPT. 1 — MAN'S NO. RESPONSIBLE — APPD. DEPT. CHGD. H.a.C.

FIGURED BY — DISPOSITION Scrapped or Stored — DISPOSITION MADE BY — REC'D BY STORES DATE NO. — CONDITION OF FINISH Semi — APPD. SHOP SUPT.

WT. OF ONE — TOTAL WT — MAT. COST — LABOR COST — OVERHEAD COST — TOTAL COST — CHARGE ACCOUNT — CHARGE AMOUNT — CREDIT ACCOUNT — CREDIT AMOUNT

SALVAGE PER LB. — VALUE TOTAL — MAT. LOSS — LABOR LOSS — OVERHEAD LOSS — TOTAL LOSS

Issued by Despatcher in 3 copies, White, Green and Pink for all material that cannot be used for the purpose for which it was requested. White Copy to Dept. Charged for approval and to accompany matl. to Stores then to Main Office. Green Copy to accompany Material to Stores and after Rejected Material is signed for to be returned to Despatcher issuing same for filing. Pink Copy to be forwarded promptly to Stores Dept., by Despatcher issuing same. FORM 830 A

Fig. 12. When Material is rejected on Account of Failure to pass Inspection, a Rejected Material Report is required stating the Nature and Cause of Rejection

are hung on boards. The operation order for the job in process hangs on an upper pair of hooks, while that for the next operation in order hangs directly beneath it. These boards may be seen in Fig. 13.

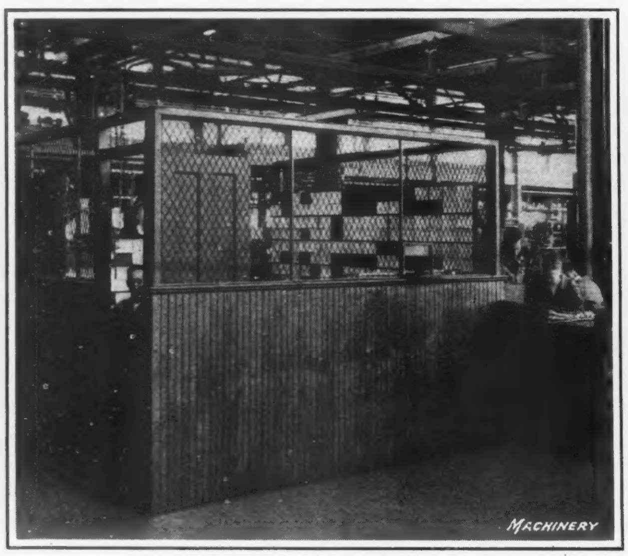


Fig. 13. Dispatcher's Office from which the Records of the Work in Progress are kept and the Jobs distributed

The presentation of the envelope, Fig. 11, in which the blueprint and remaining operation orders are enclosed, to the dispatcher's office by the workman or foreman is the request for a new job. The dispatcher then removes from the board the operation order for the job just completed, and in assigning the next work for that machine, advances the operation order hanging on the lower pair of hooks to the upper pair, and substitutes the next job in order. In this way the dispatcher can readily maintain a steady supply of material for each machine within his territory. The order slips for the finished jobs are filed in the dispatcher's office and are collected by the inspector at regular intervals. After inspecting the work and making the proper notations as regards the number of parts passed, the amount

Fig. 14. Partial View of the Planning Department where the Scheduling and Routing of All Work is done

DELAYS AND FAILURES

Jobs completed 45

Failures 3

ORDER NO.	PART NO.	PIECES	PART NAME	DEPT.	STOCK NO.	OPERATOR	TIME ALLOWED	TIME OVER	STEPS TAKEN TO PREVENT RECURRENCE
861 LC-16	2 LR 31 A9	3	Long feed screw nut	12	2143	Lockwood	0.2	1.1	Slow man
872 GL-11	1 BC 56 A15	1	Clutch Shifter Lever	12	601	Longley	0.5	3.1	Hard casting
772 GL-45	1 BD 140 B24	8	Ratchet Lever End Plate	12	1205	Buresso	0.7	0.8	Work done by apprentice

Fig. 15. When more Time has been consumed in an Operation than has been allowed, or, when Failures occur, a Daily Report stating the Facts is required

NOTICE
READ THIS
Use this form only to correct errors in Drawings, Patterns Machining or Castings. Not to be used for necessary standard operations.

Put this Number on Service Cards and Requisitions

FOREMAN'S REMACHINING ORDER TO DEPT. NO 37 — NO F.O. 9295 A

ORDER NO	LOT NO.	NO. OF PCS	DESCRIPTION	ISSUED BY	DATE	PART. NO.
872 GL 11		1	Clutch Shifter Lever	EgB.	7/4/	1BC56A15

DATE FINSHD	BY	STORES REQ. NO.	OPER ORDER NO	CHGE. TO DEPT.	APP'D. BY DEPT. CHGD	PATTERN NO.	DRAWING NO.
			51587	12	Sanbury		

THE FOLLOWING SPECIAL WORK IS REQUIRED BY DEPT. NO. 34 Ballard FOREMAN
(TO BE SIGNED BY FOREMAN OF DEPT REQUIRING WORK DONE)

ON ACCOUNT OF Sandhole in casting

Babbitt sandhole

WHAT HAS BEEN DONE TO GUARD AGAINST A RECURRANCE

(TO BE FILLED IN BY FOREMAN OF DEPT. CHARGED)

CHARGE ACCT. NO.

CHECK CLASSIFICAT'N THUS V
- A DEFECTIVE CASTING
- B DEFECTIVE WORKMANSHIP PREV. OPER.
- C DEFECTIVE WORKMANSHIP PRES. OPER.
- D ENGINEERING DEPARTMENT
- E

APPROVED

SHOP SUPT.

REGISTERED

APPROVED SUPT	EXTENDED	CHECKED	MATE'L COST	LAB COST	TOTAL COST	EQUIP. NO

To be issued only to correct errors in Drawing, Patterns, Machining or Castings.
Issued by Despatcher in three copies. White, Green and Pink.
White copy to be approved by Foreman of Dept. to be charged and Shop Superintendent before work is started and forwarded to Main Office.
Green copy to accompany Material and forwarded to Main Office when finished, to be costed and returned to Foreman of Dept. charged.
Pink copy to be retained by Despatcher issuing same. FORM 632 H. M. & M. INC. P. M. WKS.

Fig. 16. Errors occurring on the Drawings, Patterns, in the Machining Operations, or in the Foundry sometimes require the Work to be remachined. An Order for performing this Extra Operation must be made out

of time consumed, etc., the inspector returns the slips to the dispatcher, and one set is delivered to the planning department where the information is recorded on follow-up records, and then filed. The other set of operation order slips is retained by the dispatcher for future reference. It is, apparent that the selection of the follow-up job by the dispatcher is governed by the work schedule (Fig. 5) for the machines in the department in which the work is being performed, and that this schedule also furnishes the date on which the job should be finished.

As soon as the work on any part has been completed in a department, the dispatcher issues directions for transporting the work to the next department in order, as indicated on the opposite side of the envelope, Fig. 11. If for any cause the work is rejected by the inspector, the dispatcher, when examining the operation order slips, issues a rejected material report, Fig. 12, which must be signed by the inspector. These slips are made out in triplicate, and contain the department number and the name of the foreman, in addition to the description of the work and the cause for rejection. The disposition of the rejected stock is determined by the storekeeper, to whom one of these slips is sent. He then decides whether the piece is to be replaced or not. The slip is required to be signed by the foreman

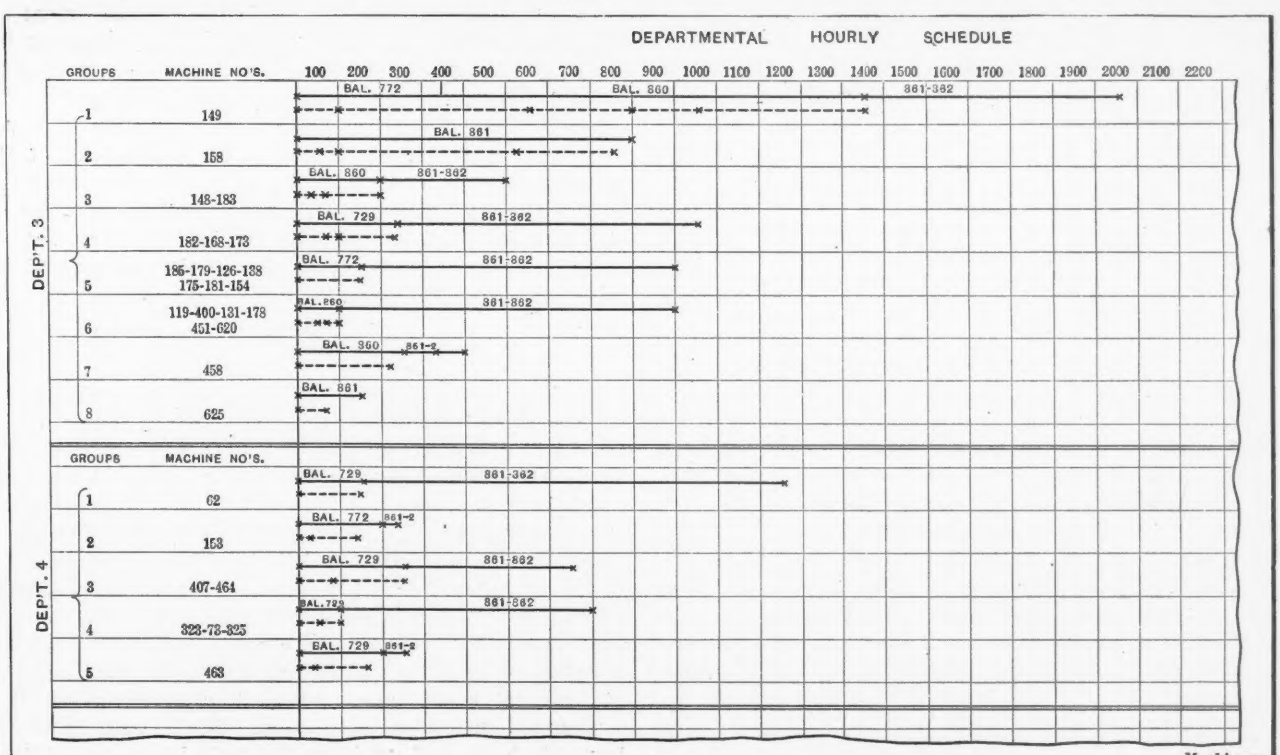


Fig. 17. Diagrammatic Chart from which the Number of Hours assigned to Each Machine Group may be determined as well as the Amount already used, so that Time Estimates may be made in Anticipation of New Orders

of the department in the space marked "Approved Department Charged." At the end of each month a cost account for the amount of spoiled work is submitted to the foreman. This has the effect of producing a greater amount of precaution in the department and results in keeping the amount of rejected material down to a minimum. It is evident that an excessive amount of rejected material is an unfavorable condition against which the foreman constantly guards in order to maintain a high degree of efficiency for his department.

If more time is consumed on a job than had been estimated or established by the planning department, the foreman determines the reason for this and writes it on the back of the operation order slip. These entries are placed on a "delay and failure" sheet, which is shown in Fig. 15, and all information concerning the job is entered, including the time consumption. These are daily reports giving the number of jobs completed and the number of failures, and the total amount of time in excess of that planned is placed at the bottom of the sheet. These daily reports are sent to the superintendent and to the production manager, so that these executives are posted daily as to the causes for not meeting the production time and the steps being taken to prevent a recurrence. For example, if the cause of the delay or failure lies with the foundry, this department is charged with the inefficiency, which serves to create a greater effort on the part of the foundry foreman to prevent similar delays or failures in his department.

The necessity for remachining work requires a foreman's remachining order, Fig. 16, which is issued in three colors and only as a result of errors which are due to poor drawings, patterns, machining, or casting. One of these copies is filed by the foreman of the department in which the work is to be remachined so that he, as well as the superintendent to whom one of the copies is sent, is able to check up the quality of work that his department is doing at all times, and if there is much of this repair work, he is able to take the necessary steps to prevent it. In the case of time losses over which the operator has no influence, due credit is allowed, and an additional operation slip is filled out by the dispatcher, on which the additional time costs are entered and the proper extra charge made on the expense of the job. This slip, which is a duplicate of the regular operation order slip, contains the foreman's order number, which furnishes the authority for the extra time allowance.

Departmental Schedule and Progress Board

A departmental hourly schedule is maintained in the planning department in which the burden of each machine in the shop is diagrammatically indicated. This chart is based on the time element contained in the schedule of machines previously mentioned in connection with Fig. 5. A section of one of the sheets which constitute the hourly schedule is shown in Fig. 17. Such a schedule, in connection with routing the work, to indicate instantly the number of hours assigned to any machine, is very valuable. In furnishing the executives and the order department with the estimated dates for shipment of contemplated orders, this diagram is of prime importance, since the governing machine can be determined at a glance. The number of hours that are already assigned to a machine are shown in heavy full lines and the number consumed, in heavy dotted lines, the difference being used to estimate the earliest date on which a new order could be handled on the machine.

It is stated that, barring unforeseen delays, accurate results can be obtained by employing this chart. In the illustration, it will be seen that for department No. 3 there are eight groups of machines, some of these groups containing but one machine and others several. The schedule enables the planning department to know at once that machine No. 149 in this department is already burdened with 2000 hours' work, and that if this machine must be used on an order, it must first be cleared. Therefore, this machine is the governing one, and the only one which must be considered when making a shipment date estimate. This enables the planner to furnish a close approximation as to the date on which the various operations can be completed with the available equipment. The opposite side of the schedule contains a record of material and finished parts purchased from outside the shop, the vender's name, the dates ordered and promised, and any additional remarks which may be necessary.

In Fig. 14 a general view of a corner of the planning department is illustrated, which also shows a view of the progress board used in this department to record the state of completion of any manufacturing order listed thereon. This board records the date of shipment for each order, and that of the several steps in manufacturing. The location of the various parts after machining is indicated by markers, so that whether the work is in the unit assembly or in the erecting stage this can be quickly seen, as well as the number of parts released either for assembly or for storage. There are a number of incidental items which might be mentioned in connection with the functions of this department, but for the purpose of general analysis those to which attention has been called should serve to illustrate the scope of the work performed.

* * *

OXY-ACETYLENE WELDING APPLICATIONS IN BOILER SHOPS

Few products offer so many applications of oxy-acetylene welding in proportion to the number of operations involved in their manufacture, maintenance, and ultimate disposition, as boilers. Welding can be applied in various ways during their manufacture, in making repairs at intervals throughout their life, and in finally cutting up the worn-out boilers into scrap. Some of the applications of oxy-acetylene welding in making the various parts entering into the construction of a boiler are as follows: In cutting the sheets to facilitate handling when they are brought into the shop for laying out; in cutting out dome saddles and wash-out and cleaning holes by using a simple one-wheel attachment for circular work; and in welding holes punched wrong on the punching machines, edges or angles damaged by shears, and flanges cracked while being shaped or in fitting up.

In assembling a boiler, the dome must be driven into the saddle and the mud ring into the water space. These heavy parts can be fitted by applying a welding flame to a small area, which permits the parts to be fitted easily. Occasionally, staybolt holes are tapped too large, and when this occurs instead of using an over-size bolt, the hole can be welded and another one of correct size drilled and tapped. In attaching the firebox to a boiler, the sheets can be welded together. One of the most profitable applications of the welding process in repairing boilers is in the reclamation of fire flues and tubes. This is accomplished by cutting off defective ends and welding on new short lengths. Patches can also be satisfactorily attached to firebox sheets, and the edges of riveted fireboxes can be calked by welding, at small cost.

* * *

Workmen's compensation laws have been enacted in forty-three states of the Union, and in addition are in force in Alaska, Porto Rico, and the Hawaiian Islands. Only five states have no workmen's compensation laws, and these are non-industrial states in the South. Most of the workmen's compensation laws have been passed since 1910. There is a marked tendency in nearly all states to strengthen the laws in the direction of larger amounts of compensation, shorter waiting periods before payment begins, and wider scope of application. Sixteen states have established state funds for insuring, at cost, the liability of employers; and in seven of these states, the state insurance is exclusive, eliminating commercial insurance competition. Ohio's state insurance law, which is said to have the united support of both employers and employes, is claimed to have given the best results to both industry and labor.

Industrial Conditions in Spain

By D. RAMON CASALS, Barcelona, Spain

GENERALLY speaking, there is considerable activity in the Spanish industry and there doubtless is a period of great development ahead, but at least 80 per cent of the prospective buyers of machine tools are not placing orders at the present time, because they expect either a fall in prices or are awaiting more suitable conditions in the political, industrial, and economic situation. Many Spanish manufacturers have orders on hand which would make it possible for them to enlarge their works. The automobile industry has been prosperous during the last year, and the makers are confident that this industry can be permanently established in Spain. Of the automobiles in Spain at present, from 80 to 85 per cent are of foreign make, mostly American, French, and English. As yet there is no firm that has started to manufacture trucks in Spain in spite of the fact that the use of this class of vehicle is greatly increasing. The duty on automobiles is 300 pesetas ($41.46 at present exchange) per 100 kilograms (220 pounds). This high tariff, it is believed, will make it possible for the Spanish makers to compete in the domestic market. In spite of the increased wages paid, the wages in Spain are still lower than in most other industrial countries with which Spain competes.

Important Industrial Developments

Among the automobile builders in Spain may be mentioned America Autos S. A. in Barcelona; this company up to the present time has built only a few cars, but it is now erecting a large and modern works for the manufacture of cars in quantity. This company has also made considerable developments along the line of improved wheels, a so-called "elastic" wheel having been developed which is used as a substitute for the prevailing types of pneumatic tires. This wheel has been tried out under actual running conditions, and has given excellent results. Other automobile companies in Barcelona as well as the Hispano firm of Guadalajara have also increased their facilities considerably. A general development is also apparent in other industries, chiefly among the makers of railway equipment. Hitherto most of the locomotives of Spain have been imported, but a new works established here is prepared to build fifty engines a year. Several factories devoted to the making of flying machines have made contracts with the government for the building of planes for mail service. One Barcelona firm is experimenting with a plane which will rise vertically after having attained a 10-degree inclination at the beginning of the flight. This firm expects to win the prize of 500,000 francs offered by the firm of Michelin in France for a plane capable of rising vertically from the ground.

The Machine Tool Field

In the machine tool field, the few makers that there were in Spain are decreasing in number. Most of the domestic machines, although built in accordance with American models, did not prove reliable, as they were made from inferior materials and by men who were inexperienced in this class of work. There are some dealers who sell domestic-made machines under the pretense that they are imported. Makers of small tools are quite numerous, and they also endeavor to sell their products as if made in foreign countries. These tools are cheaper when manufactured in Spain, and as a rule give better results than the machine tools that have been built by domestic concerns.

The largest demand for machine tools in Spain is for lathes. Milling machines are also in demand, and in nearly every case American machines are asked for. The tariff on machine tools is quite low, amounting only to 20 pesetas ($2.76) per 100 kilograms (220 pounds). The present rate of exchange is 13.82 cents per peseta (normal, 19.3 cents).

German and English Competition

There has been some evidence of German competition during the last four months, and some machine tools from Germany have arrived in Spain. Most of these machines, however, are those that remained in stock in Germany at the end of the war; the majority are new machines, and some are second-hand. The prices of these machines are quite low. A good American lathe with quick-change gear-box, 16 or 18 inches swing, costs from 12,000 to 14,800 pesetas in Spain; whereas, the German machines, when 5 marks were equal to 1 peseta, would sell for from 4000 to 5000 pesetas. At the present time, dealers in German machine tools here have no stocks on hand, but deliver from the German works in about eight weeks. The prices quoted seem low enough, and the smaller plants appear to be anxious to take advantage of these German offers, but the large factories belonging to more important firms, which have had an opportunity to compare the results obtained from German machines with those of American machine tools are at present asking for bids only from dealers in American and English tools.

The competition with English machine tool builders is beginning to be more keen. The delivery quoted by the British firms is satisfactory, but the prices are considered high. There is also competition from Sweden. The machinery offered by that country is considered in Spain to be comparable with the machines offered by Germany. A considerable amount of machinery is also coming from Switzerland.

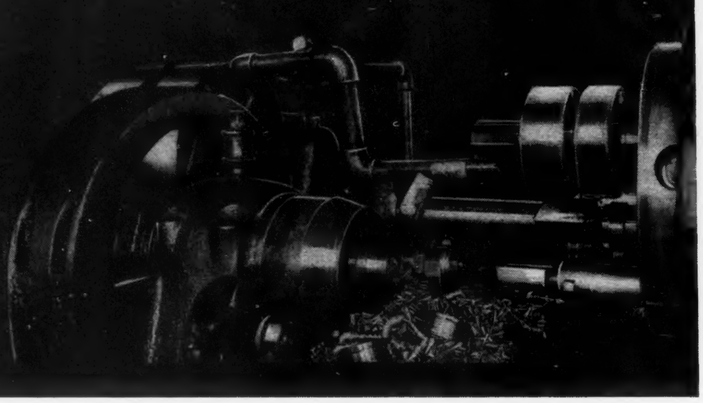
Labor Conditions

Labor conditions are not favorable to the development of important industries. Although most of the factories in Spain are able to obtain an abundance of orders, they have difficulties with their workmen, and these difficulties seem to be increasing rather than decreasing. Many of the factories that are trying to develop along modern lines find that they must act very carefully in the adoption of modern labor-saving machinery and in the introduction of modifications tending to reduce the labor cost, because such efforts serve as a reason for a strike, not only in one factory, but in a whole branch of the industry. There has been a considerable increase in wages, and working hours have been reduced from one to two hours a day. The following table shows a comparison of wages in and around Barcelona and other industrial centers in 1914 and 1920:

	Pesetas per Hour 1914	1920
Lathe operators	0.45 to 0.60	1.55 to 1.80
Milling machine operators	0.45 to 0.60	1.55 to 1.80
Bench hands	0.35 to 0.50	1.40 to 1.60
Assemblers	0.40 to 0.60	1.50 to 1.80
Helpers	0.30	1.20
Molders	0.50	1.70

In view of the increased wages it is evident that it is necessary to procure labor-saving machinery in order to increase output. There is not a demand as yet for many automatic machines, because the output of each class of manufacture is not large enough for the advantageous use of that kind of machine tool, but there is a considerable market for turret lathes and universal milling machines, because these machines would greatly decrease manufacturing costs.

Design of Circular Forming Tools



Calculations for Designing Circular Forming Tools Having Top Rake

By EARL H. SMILEY and J. H. DAVIS

As the circular forming tools used on automatic screw machines have the cutting edges below the center line of the tool in order to provide clearance, the radial length of the step or shoulder on the tool must be less than the corresponding radial length of the shoulder to be formed on the work, in order to compensate for the difference between heights of the work and tool centers. When the circular tool has top rake, the radial length of each step must be still further reduced, due to the inclination of the cutting edge. Tools without top rake may be used to advantage when cutting brass and drill rods of very small diameters, but when cutting steel, bronze, or copper, a rake on the form tool is necessary in order to give a better cutting action.

Formulas for standard sizes of circular tools without rake were published in the April number of MACHINERY (page 765), and tables such as the one beginning on page 830 of MACHINERY'S HANDBOOK may also be used for obtaining the radii of various steps on the tools more readily than by the use of formulas. This article will be confined to the design of circular forming tools having rake.

Circular forming tools with or without rake may be made by first making a master tool, which is used to make a straight form tool, the latter finally being employed for turning the circular form tool. The master tool method (which was fully described in the January, 1920, number of MACHINERY) is necessarily expensive and is not warranted except for the production of parts in large quantities.

When circular tools having rake are made without resorting to the form tool method, the diameters of the different steps on the tool may be calculated readily by the use of the formulas which are to be given, together with their derivation. As some of the dimensions of these forming tools have been standardized for different sizes of screw machines, the design of the forming tools is simplified. For instance, the outside diameter and amount that the cutting edge is offset relative to the center of the tool, is standard for the tools used on a given size and make of machine.

Formulas for Circular Tools Having Rake

In order to determine the shape and the number of steps required on the forming tool, the sequence of operations for producing the piece to be made should first be laid out. Fig. 3 shows the relative positions of the forming tool and work. The radius of each step of the tool is then determined. The derivation of the formula for finding the radius of a given step on the tool will be made clear by referring to the

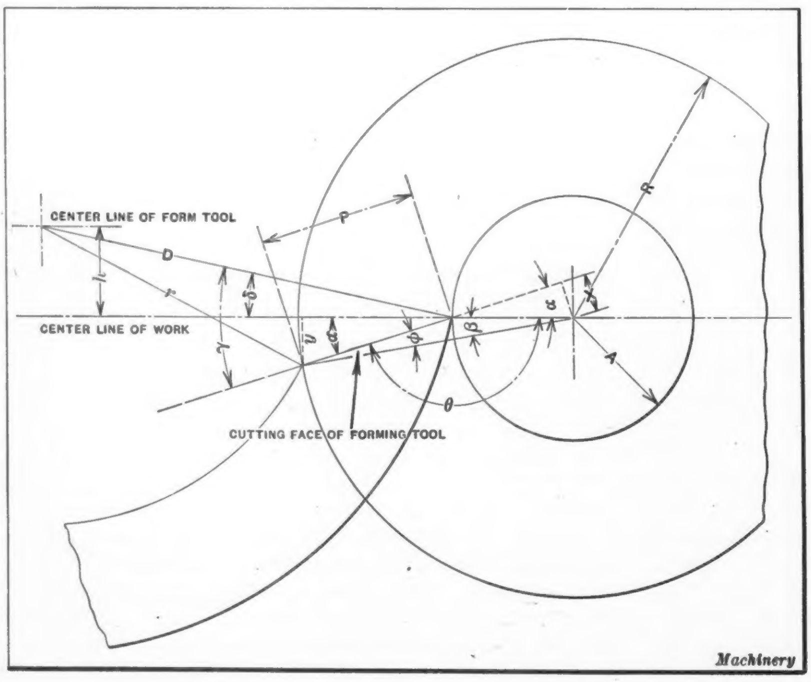


Fig. 1. Diagram showing Construction Lines used in deriving Formula for Circular Forming Tools having Rake

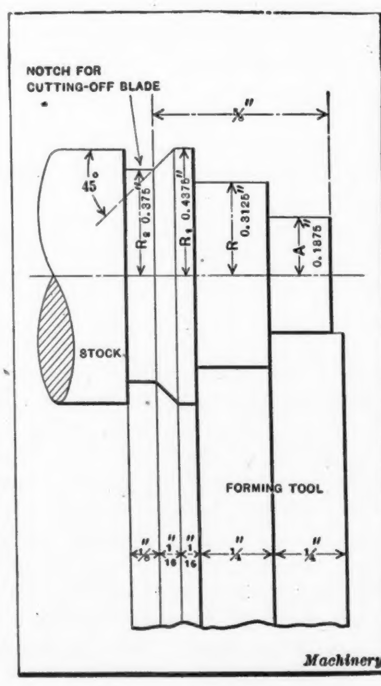


Fig. 2. Practical Example illustrating Forming Tool Calculations

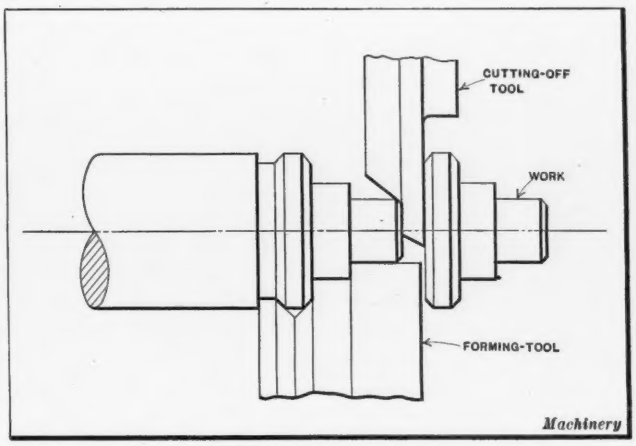


Fig. 3. Example illustrating Application of Forming and Cutting-off Tool

diagram, Fig. 1, which represents the cutting edges of the tool and the two diameters on the part formed by the tool. The notation used in the formulas conforms to the lettering on this diagram, and is as follows:

A = small radius on part to be turned;
R = large radius on part to be turned;
D = outside radius of circular forming tool;
h = vertical distance between center lines of forming tool and work;
a = angle of rake on cutting face of forming tool;
r = radius required on tool for turning a given radius on the work.

An inspection of the diagram will show that:

$$\theta = 180 - a \qquad (1)$$

$$\sin\phi = \frac{X}{R} \qquad \text{and} \qquad \sin\theta = \frac{X}{A}$$

Then

$$X = R\sin\phi \qquad \text{and} \qquad X = A\sin\theta$$

$$R\sin\phi = A\sin\theta$$

$$\sin\phi = \frac{A\sin\theta}{R} \qquad (2)$$

$$\beta + \phi + \theta = 180 \text{ degrees}$$

$$\theta = 180 \text{ degrees} - a$$

Subtracting

$$\beta + \phi = a$$

$$\beta = a - \phi \qquad (3)$$

$$\sin\theta = \frac{y}{P} \qquad \text{and} \qquad \sin\beta = \frac{y}{R}$$

$$y = P\sin\theta \qquad \text{and} \qquad y = R\sin\beta$$

$$P\sin\theta = R\sin\beta$$

$$P = \frac{R\sin\beta}{\sin\theta} \quad (4) \qquad\qquad \sin\delta = \frac{h}{D} \quad (5)$$

$$\gamma = a + \delta \qquad (6)$$

From the law of cosines the following formula is derived:

$$r^2 = P^2 + D^2 - 2PD\cos\gamma$$

Solving for r

$$r = \sqrt{P^2 + D^2 - 2PD\cos\gamma} \qquad (7)$$

$2r$ = the required diameter of the forming tool to cut the diameter $2R$ on the work.

When the part to be turned has several diameters, the radius of each step on the tool may be determined by successive calculations, always using the smallest radius on the work (as A, Fig. 1) for all calculations on the same tool.

The accompanying table, which applies to the circular tools used on four sizes of Brown & Sharpe screw machines, is convenient for the designers of these tools, as it contains most of the dimensions required on the working drawing. As will be seen, radius D and certain other dimensions are standard for all tools used on a given size of machine. As the product of $2D\cos\gamma$ (see Formula 7) is the same for each machine, the logarithm of this product is given in the table for the convenience of those who desire to use logarithms. When logarithms are employed in the calculations, a seven-place table should be used, preferably, to insure a result that is accurate to three decimal places or to thousandths of an inch.

Example of Forming Tool Calculations

The method of calculating the diameters of a forming tool having top rake will be given to illustrate the procedure. The forming tool for making the dowel-screw shown in Fig. 2 will be taken as an example. Assume that the rake angle equals 8 degrees and that the dimension for that step on the tool which is to turn a radius of 0.3125 inch is to be determined first. Inserting these values in the formulas previously given, we have:

$$\theta = 180 - 8 = 172 \text{ degrees} \qquad (1)$$

$$\sin\phi = \frac{0.1875 \times 0.13917}{0.3125} = 0.0835 \qquad (2)$$

$$\phi = 4 \text{ degrees } 47 \text{ minutes, nearly}$$

$$\beta = 8 \text{ deg.} - 4 \text{ deg. } 47 \text{ min.} = 3 \text{ deg. } 13 \text{ min.} \qquad (3)$$

$$P = \frac{0.3125 \times 0.05611}{0.13917} = 0.126 \qquad (4)$$

$$\sin\delta = \frac{0.25}{1.5} \qquad (5)$$

and

$$\delta = 9 \text{ degrees } 36 \text{ minutes}$$

$$\gamma = 8 \text{ deg.} + 9 \text{ deg. } 36 \text{ min.} = 17 \text{ deg. } 36 \text{ min.} \qquad (6)$$

$$r = \sqrt{0.126^2 + 1.5^2 - 0.126 \times 2 \times 1.5 \times 0.95319}$$

$$= \sqrt{1.906} = 1.3806 \qquad (7)$$

Therefore the diameter on the forming tool for cutting a radius R of 0.3125 inch equals 1.3806 × 2 = 2.7612 inches. The radii of the other steps of the tool may be determined in the same way by substituting the values 0.4375 and 0.375 for radius R.

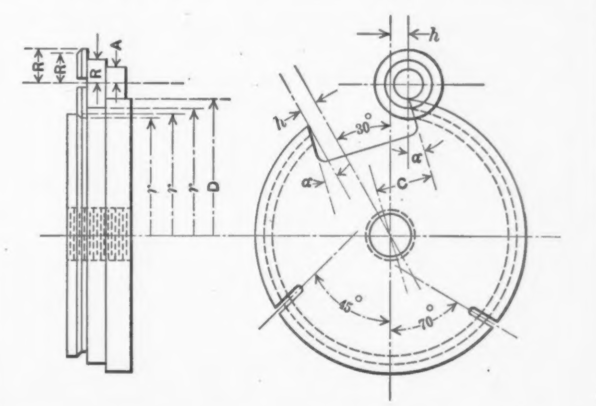
While the radius can be calculated as shown in the foregoing, the use of logarithms will be found more convenient and also more accurate when a seven-place table is used. The solution of the preceding example by the use of logarithms follows:

$$A = 0.1875 \text{ and } \log A = \bar{1}.2730013$$

By adding and then subtracting 10, the actual logarithm is given a positive characteristic so that it will conform to the logarithms as given for trigonometrical functions; thus

$\bar{1}.2730013 = 9.2730013 - 10$ or, as commonly written, 9.2730013, the -10 being omitted.

DIMENSIONS AND CONSTANTS FOR CALCULATING CIRCULAR FORMING TOOLS



Type of Mach.	Max. Diam. Stock, Inch	Max. Length of Cut, Inches	Max. Length of Feed, Inches	Diam. of Formed Tool Inches	h, Inch	C, Inches	Size Tapped Hole	Constants	
								D^2, Inches	Log $2D \times \cos\gamma$
A	5/16	1¼	2	1¾	⅛	0.245	⅜-16	0.765625	0.2254146
B	½	2	3	2¼	5/32	0.311	½-13	1.265625	0.3350608
C	⅞	3	4	3	¼	0.426	⅝-11	2.250000	0.4563164
D	2	5	6	4	5/16	0.584	¾-10	4.000000	0.5826815

Machinery

$R = 0.3125$ and $\log R = \bar{1}.4948500$ or 9.4948500

$\text{Log} \sin \theta = 9.1435553$

$\text{Log} \sin \phi = \log 9.2730013 + \log 9.1435553 - \log 9.4948500$
$= \log 8.9217066$

Hence

$\phi = 4$ degrees 47 minutes 24 seconds

$\beta = 8$ deg. — 4 deg. 47 min. 24 sec. = 3 deg. 12 min. 36 sec.

$\text{Log } P = \log 9.4948500 + \log 8.7481552 - \log 9.1435553$
$= \log 9.0994499$

$\text{Log } P^2 = 9.0994499 \times 2 = 18.1988998 - 20$ or $\log 8.1988998$
$= 0.015809$

$r = 0.015809 + 2.25 - (\log 9.0994499 + \log 0.4563164)$
$= 1.3806$

$2r = 2.7612$ inches = the required diameter on the forming tool to cut a radius R equal to 0.3125 inch.

Calculations for Combined Forming and Cutting-off Tools

When the heel of a cutting-off tool is required to pass the center of the work, as when the tool is used to form and cut off at one operation, this changes the relation between the cutting edge of the tool and the diameter at the step, so that another set of formulas must be derived before designing the tool. The diagram Fig. 4 shows graphically the meaning of the following notation:

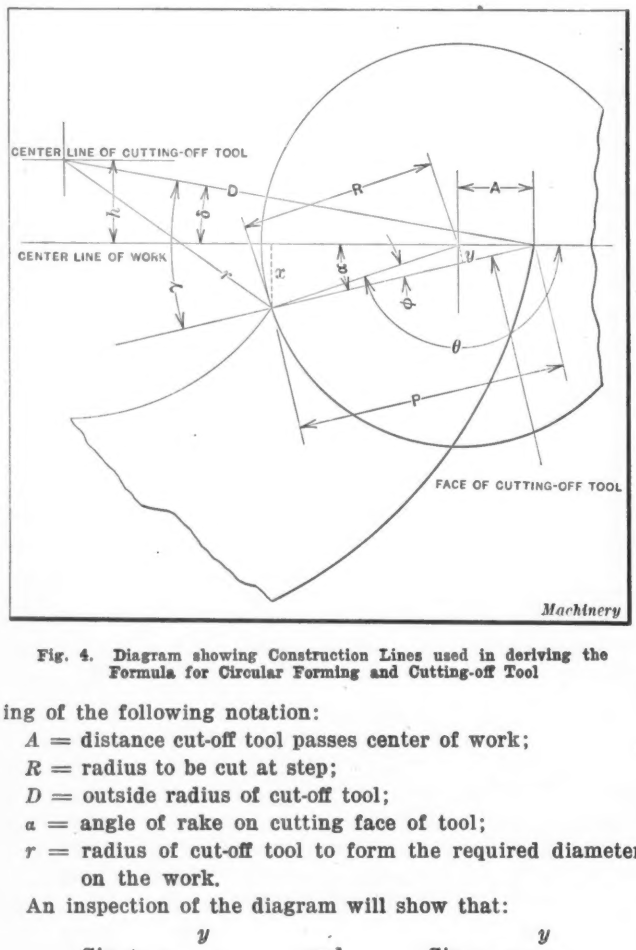


Fig. 4. Diagram showing Construction Lines used in deriving the Formula for Circular Forming and Cutting-off Tool

A = distance cut-off tool passes center of work;
R = radius to be cut at step;
D = outside radius of cut-off tool;
α = angle of rake on cutting face of tool;
r = radius of cut-off tool to form the required diameter on the work.

An inspection of the diagram will show that:

$$\sin \phi = \frac{y}{R} \quad \text{and} \quad \sin \alpha = \frac{y}{A}$$

$$y = R \sin \phi \quad \text{and} \quad y = A \sin \alpha$$

$$R \sin \phi = A \sin \alpha$$

$$\sin \phi = \frac{A \sin \alpha}{R} \qquad (8)$$

$$\alpha + \phi + \theta = 180 \text{ degrees}$$

$$\theta = 180 \text{ degrees} - (\alpha + \phi) \qquad (9)$$

$$\sin \alpha = \frac{x}{P} \quad \text{and} \quad \sin \theta = \frac{x}{R}$$

$$x = P \sin \alpha \quad \text{and} \quad x = R \sin \theta$$

$$P \sin \alpha = R \sin \theta$$

$$P = \frac{R \sin \theta}{\sin \alpha} \qquad (10)$$

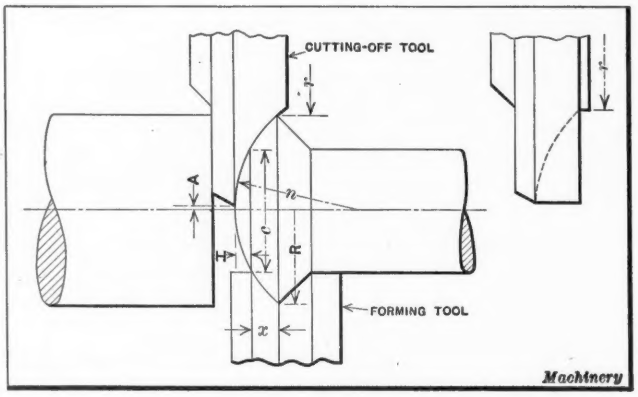


Fig. 5. Forming and Cutting-off Tools for forming a Spherical End on Screw-head

$$\sin \delta = \frac{h}{D} \qquad (11)$$

$$\gamma = \alpha + \delta \qquad (12)$$

$$r = \sqrt{P^2 + D^2 - 2PD \cos \gamma} \qquad (13)$$

Forming and Cutting-off Tools for Forming a Spherical End on Work

When a screw-head or other part is to have a spherical end, the forming tool may be used to turn part of the spherical surface (as illustrated in Fig. 5), and the cutting-off tool completes the curvature during the cutting-off operation. Formulas (1) to (7), inclusive, are used for the calculations, but it is first necessary to determine either the height H or the length c of the chord extending from the point where the forming tool completes its part of the work.

If H = height of chord;
n = radius of spherical shaped part;
c = length of chord

Then

$$H = n - \tfrac{1}{2}\sqrt{4n^2 - c^2} \qquad (14)$$

If the conditions of the problem are such that the length c of the chord is required, the formula can be transposed as follows:

$$c = 2\sqrt{H\,(2n - H)} \qquad (15)$$

The screw-head shown in Fig. 6 will be used as an example to illustrate the method of calculating the tools. It will be seen from Fig. 5, that the length c of the chord in this case is 5/8 inch, as the forming tool is to turn the head down to the same diameter as the body of the screw; therefore, it is necessary to find height H. The radius of the head n equals 1.6875 inches and c equals 0.625 inch. Inserting these values in Formula (14), we have:

$$H = 1.6875 - 0.5\sqrt{4 \times 1.6875^2 - 0.625^2} = 0.029$$

$$x \text{ (see Fig. 5)} = 0.096 - 0.029 = 0.067$$

The next step is to calculate radius r of the forming tool, by the use of Formulas (1) to (7) inclusive, as previously explained. As Fig. 5 indicates, the cutting-off tool is to finish that part of the spherical end which is not turned by the forming tool, the work of the cutting-off tool beginning where the spherical surface left by the forming tool ends. Since the finished screw will drop off before the cutting-off tool has reached the center, some allowance must be made

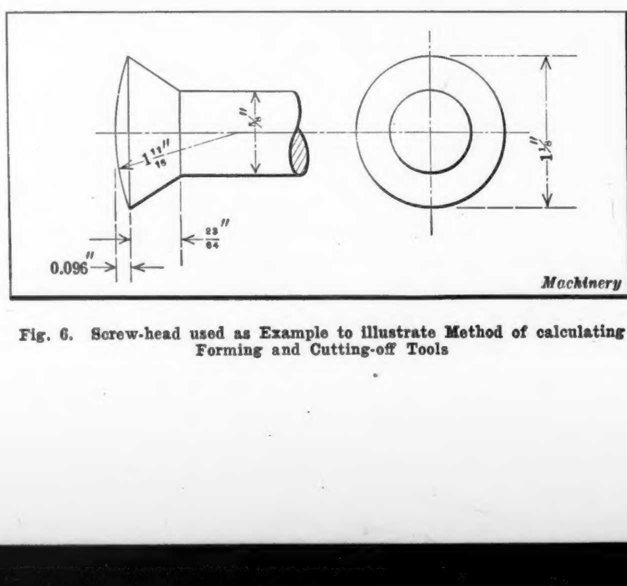


Fig. 6. Screw-head used as Example to illustrate Method of calculating Forming and Cutting-off Tools

when calculating the cutting-off tool so that the screw-head will be correctly formed before it is severed. If 1/32 inch is allowed as the diameter of the teat on the end of the stock, the radius A used in the calculations for determining the tool radius r will equal 0.015 inch. This value of 1/32 inch is approximate, but is close enough for all practical purposes, and it allows the complete arc to be formed before the finished screw drops off the bar.

We shall assume that the cutting-off tool to be used for the screw-head illustrated in Fig. 6 has a rake angle a of 8 degrees, and it is to be used on a Type D machine; therefore, the outside radius D of the tool equals 2 inches. (See table previously referred to.) The radius R of the screw-head equals 0.5625 inch. Having these values we can proceed to determine the radius r of the tool corresponding to the radius R of the head when the point of the cutting-off tool is within 0.015 inch of the center.

$$\theta = 180 \text{ degrees} - 8 \text{ degrees} = 172 \text{ degrees} \qquad (8)$$

$$\sin \phi = \frac{0.015 \times 0.13917}{0.5625} = 0.0037 \qquad (9)$$

$$\phi = 0 \text{ degrees } 12 \text{ minutes } 46 \text{ seconds}$$

$$\beta = 8 \text{ deg.} - 0 \text{ deg. } 12 \text{ min. } 46 \text{ sec.} = 7 \text{ deg. } 47 \text{ min. } 14 \text{ sec.}$$

$$P = \frac{0.5625 \times 0.13549}{0.13917} = 0.5476 \qquad (10)$$

$$\text{Sin } \delta = \frac{0.3125}{2} = 0.15625 \qquad (11)$$

$$\delta = 8 \text{ degrees } 59 \text{ minutes } 21 \text{ seconds}$$

$$\gamma = 8 \text{ degrees} + 8 \text{ degrees } 59 \text{ minutes } 21 \text{ seconds}$$
$$= 16 \text{ degrees } 59 \text{ minutes } 21 \text{ seconds} \qquad (12)$$

$$r = \sqrt{0.5476^2 + 2^2 - 2 \times 0.5476 \times 2 \times 0.95636}$$
$$= 1.4849 \text{ inches} \qquad (13)$$

The toolmaker when making the cutting-off tool can readily turn or grind it to the required diameter ($2r$) by forming a shoulder on the tool as illustrated by the view at the right-hand side of Fig. 5; then by the use of a radius tool of the proper shape, the cutting-off tool can be turned to the radius of the screw-head, the tool blank being turned away as indicated by the dotted line.

* * *

INDUSTRIAL COST ASSOCIATION

The Industrial Cost Association, which has executive offices in the People's Bank Bldg., Pittsburg, Pa., reports that considerable progress has been made in enlisting the interest of firms and corporations and of industrial organizations. The objects of the association are to stimulate the interest of all manufacturers in accurately determined costs; to standardize cost and accounting nomenclature; to establish governing principles; to simplify cost accounting; to educate the members in the use and advantages of graphic charts and other modern methods of cost analysis and control; to assist members of the association who are identified with cost committees of trade organizations in formulating uniform cost methods, and to recommend to members the adoption of such uniform methods; to facilitate the elimination of unintelligent competition by encouraging the interchange of cost data among members engaged in similar lines of industry; to provide a forum for the discussion of cost problems and practices through general and local meetings; to gather and disseminate news of interest to members; to establish a library of cost literature, and to maintain a bureau of information through which members may be assisted in the solution of their individual cost problems; and to coordinate the efforts of members to the end that cost of production may be considered in its proper relation to the complex problems of industrial management. Membership in the association is open to officers, directors, and managers of industrial corporations, firms, and trade associations, and to employes having executive supervision of cost accounting.

EXECUTIVES AND HOW THEY ARE MADE

By M. L. JEFFREY
Superintendent, Columbia Axle Co., Cleveland, Ohio

Experience has proved that the most successful managers of industrial undertakings are men who in their younger days started to work as common laborers or machine operators and forced their way upward by having a solid organization in back of them. A man usually starts out in the business world with the determination to make a success of himself and win promotion. The reception that he receives controls to a great measure his future. Few people realize the amount of influence which a foreman, who has direct control of a man, has in shaping and developing his future usefulness and ability to advance to a higher position. Neither do they realize the influence which the workman has in shaping the future advancement of his foreman. However, the success of the workman reflects upon his supervisor.

The first step in shaping the usefulness of a future employe is to interview him properly. At this time it is highly important to impress upon him the high standards of the company and the kindly interest that it takes in its employes. Even though an applicant for a position is not hired, such an interview will give him a good opinion of the company and he will eventually pass on to others this opinion. The fact that a man is a first-class lathe operator alone should not qualify him for a position. He should be the type of man who will prove himself a loyal, honest, and agreeable employe. Only such men are wanted who are dependable, anxious to grow with the organization, and who will work in its interest. After a man is employed, he immediately begins to form his opinion of the concern, and sets his plans for the future accordingly.

"A proper start is the job half finished," is an old saying which may be well applied to new emplcyes. It is a duty of the foreman to become acquainted with an employe as soon as the latter arrives in his department, and display an interest in the man by showing him the place or machine to which he is assigned. The foreman should explain the duties of the new workman, giving instructions as to what methods it is desirable for the man to use in his work and acquainting him with any other information that might save him from embarrassment among the men during his first few and strange days in the shop. If this procedure is followed, a new employe will immediately notice the interest of the foreman in making him comfortable so that he may more easily and cheerfully execute his duties from the beginning. The result is that the man goes at his work in the spirit that spells success.

When a new man has been under a foreman for a sufficient length of time for the latter to determine whether the man wants to continue, the foreman should also have determined through careful observation whether the employe is aggressive and capable of holding a better position or deserving of greater remuneration for his services. Neither of these two rewards should be delayed in the case of a deserving workman. Most men are ambitious and want to attain a higher position and greater responsibility, but foremen should remember that the men working under their supervision are responsible to some extent for their success. All men are entitled to equal consideration, a cheery word, and a pleasant smile.

Every man in a department should be given all the opportunities he deserves. In this way a foreman will gain the backing of his department, and without such support, the attainments of a foreman are small. The fact that he has men under him who can readily step into a better position or continue his duties while he is absent, not only reflects upon the good judgment of the foreman in handling men, but also paves the way for his future success and promotion. A manufacturing establishment may be likened to a ladder of which each rung is an executive position, from the lowest to the highest, which serves as a stepping-stone for progress.

Machine-hour Rate Method of Distributing Manufacturing Expense[1]

By C. HAIGH, Supervisor of Costs, General Electric Co., Schenectady, N. Y.

THERE are five methods in general use for distributing overhead expenses. These are as follows: Man-rate; man-hour; material and labor; sold-hour; and machine-hour rate. The man-rate method is the one in most general use because of its simplicity. To use this method, it is only necessary to find the ratio of total expenses to total labor for a given business, and to apply this ratio to the labor cost of each job. For a factory making one kind of product, this method of distributing overhead is quite satisfactory, but where the product itself is varied and the tools used in getting out the product are different for each of the various units produced, this method of distributing overhead is incorrect and misleading as to final results. There is no more justification for considering that one dollar's worth of labor actually applied to the product should always take the same percentage of expense than there is for the assumption that a lathe and a boring mill cost the same, are operated for the same amount, and occupy the same floor space, or that the overhead cost of maintaining benches and assembly floors is the same as the overhead cost of maintaining and operating machinery.

Application of Man-rate Method of Distributing Overhead Expense

This method of applying overhead also assumes that the highest paid workman requires the most overhead expense, when actually the lowest paid man often requires the most supervision, and frequently the machine tools used by the low-priced man are more expensive and require greater expenditures for operation and maintenance than those used by the skilled mechanic, because there is incorporated in the machine which enables lower grade labor to be used the skill that the high-grade man has in himself. Thus, if a semi-automatic machine is used for making any part, a man who is not an expert mechanic can be employed to run this machine or even several of these machines, but if this special equipment were not used a skilled man would be required to be in constant attendance on a simpler machine. It is obvious in this case that the overhead expense that is incurred in running the automatic machines is much greater in proportion to the wages paid the operator of these automatic machines than is the overhead incurred in running the mechanical equipment required by the skilled mechanic.

It is also true that even if the same wages were paid all men in a manufacturing establishment, it would still be wrong to apply the overhead to each job on the basis of a percentage of labor cost, for we would still have the condition of one man running more machines than another and of the difference in cost of the machines operated; also that some men would be occupied on jobs such as cleaning castings, checking finished product, painting, etc., which require little mechanical equipment and therefore do not increase the overhead expense at the same rate as their wages increase the direct labor payroll. From the foregoing, it would appear that the man-hour rate method of distributing expenses is a dangerous one, in some instances, and will result in a loss of money. There are cases, however, where this method may give results which will be satisfactory from the standpoint of profit, as cited in the following:

In a manufacturing establishment where the mechanical equipment is fairly well standardized, where the product, while varied as to different types, still has the same average types of output, and where these types all require substantially the same machining operations, it will be found that the ratio of profit to total output will come up to expectations when the man-rate method of distributing overhead is used. There is also a factor that must not be overlooked when considering any business, and that is, the amount of information which the man or men at the head of it have of that business independent of records, as I have frequently found that when estimating the cost of new work, allowances are made by the owner of a business for a higher expected cost due to special facilities which will be necessary and to the expectation that the bigger machines in the plant will be used on the work. By making such allowances, the final price submitted includes some of the factors of expense cost that are not actually subject to proof from any records of overhead expense which would be available if the man-rate method of distributing overhead were in use.

There is, however, a question as to how many men who manufacture a wide variety of gears can give the necessary weight to all the expense factors which will increase or decrease the cost of a particular kind of gear, and it is undoubtedly true that many of the manufacturers who are making good profits on their total business are losing money on some particular type of gear because of their lack of knowledge of the operating costs of their machines. Also that they turn down business on which there may be good profit because their selling price is figured on the basis of the average overhead which brings the price up higher than the buyer will pay.

The Man-hour Method

The man-hour method of distributing overhead has for its base the number of hours spent on a job instead of the amount of wages paid. This method is subject to the same criticism as the man-rate method in that the assumption is made that the overhead expenses have a fixed ratio to the number of hours of time spent on a job. The advocates of this method point out that certain items of expense do bear a direct relation to the number of hours worked, and include under this head the expenses of the payroll and welfare departments, compensation, insurance, and supervision. To a certain extent these items do bear a closer relation to hours worked than to wages paid, but as they represent a small part of the total expense, and as it would be erroneous to distribute the major part of the overhead on this basis, I see no advantage in this method over the man-hour basis. Moreover, it can be pointed out that we do not reduce our payroll and supervisory force every time business falls off to such a point that we lay off some of the men, and therefore, the cost per man-hour of operating these departments would fluctuate sufficiently to nullify any advantage gained over the man-rate method, particularly where this advantage consists chiefly in compensating for the difference in labor rates by substituting hours worked for wages paid.

Material and Labor Basis

The application of overhead on the basis of prime cost (material and labor) does not seem to be in very general use. This method requires that the total expenses of a business be divided by the sum of the direct labor and direct ma-

[1]Paper read before the convention of the American Gear Manufacturers' Association, October 29, 1920.

terial and that the ratio or percentage so obtained be applied to the direct material and labor cost of each job turned out. It is manifestly wrong to apply this method to the product of a business that uses various kinds of material, but, where the product is all made from iron or steel, this method has some good points, as, by taking the material into consideration as well as the labor, we apply more accurately the expense of handling the material in the shop which, of course, varies with the size of the piece handled. In a shop using both copper and iron castings, this method would be worse than the two previous ones, as by adding the value of a copper casting to the labor of machining it, we would get a total figure which would carry a very high amount of expense; this, when compared with the expense cost applied to an iron casting of identical size requiring about the same amount of labor, would indicate that the expense cost of machining the copper casting was as much higher than that of the iron casting as the difference in the price per pound of copper and iron.

This method has many of the same kind of inherent defects as the man-rate and man-hour methods, as we would still be applying an average expense to jobs instead of an actual cost, the difference between this and the other two systems being only that the material is added to the labor before determining the expense to be applied. Even were this method correct for some kinds of business, the places where it could be applied would be limited in number, and this method could never be applied generally.

The Sold-hour Plan

The sold-hour plan of distributing expenses provides that the total direct labor wages in a department be divided by the number of hours worked in the same period to get a flat average cost per hour for labor. The time in hours consumed on any job is valued at this flat rate per hour, and the result is called the direct labor cost. The expense is applied on the man-hour method previously mentioned.

This method is not in very general use, and little can be said in its favor. The man-hour method of distributing expenses has been criticized before and not much need be said regarding the determination of labor costs under this plan, as unless the rates paid workmen were practically uniform, still another error would be included in the final cost by using an average rate per hour for labor.

There are other methods of distributing overhead for special kinds of business, but because of their limited application, they will not be included here.

The Machine-hour Rate Method

The machine-hour rate method consists of distributing all the manufacturing expenses of an establishment by a charge to each job of the overhead cost of operating the machines and other facilities used on that job. This overhead charge is not an average for the whole plant or department, but is, as nearly as possible, the actual overhead cost of maintaining and operating each of the machines, group of machines, benches, etc., which are found in the plant. By the proper use of this method it is possible to show the difference between the expense cost of a boring mill and a lathe, a gear-cutter and a splining machine, etc.

To install a machine-rate method, the number of feet of productive floor space available for manufacture is first found, eliminating the space used for foremen's offices, stairways, wash-rooms, stock-rooms, etc. The number of square feet so obtained is used as a divisor for determining the cost per square foot per year for maintenance, depreciation, taxes, insurance, and other kindred charges applying against the land and building. No expenses are included in this group that are incident to the actual operation of the machines, but only those charges that apply against the empty building ready for manufacture. However, the expense of lighting and heating the building and charges of a similar nature are included. In this way a charge per square foot is obtained which is practically the same charge as the owner of a building would make if he rented it and furnished the light, heat, and water used in the building, except that he would include a profit on his investment.

The factory is next divided into production centers, including in each center machines of a similar type located together, or individual machines where there are no convenient groups. Different kinds of machines should not be included in one production center, as this would defeat the object of the system. After the division into production centers has been made, the number of square feet occupied by each center is determined, including in this area the space required for the material waiting to go on the machines, the space required for the workman, etc., and each center is charged with a part of the rental of the whole building based upon the area occupied. This division gives the rent per year for each production center, and in this way the total charges of the building which we have called rental charges would be allocated to various production centers. Thus it will be seen that one part of the expenses is now divided in such a way that these items can be included as one factor in the machine-hour rate.

The next step is to determine the actual cost of the expense items incident to the operation and maintenance of each of the production centers. These expenses consist of depreciation of the machinery and equipment, taxes, repairs, small tools, cutting oils and other charges which can be definitely allocated to the machines that have been included in one production center. If a small group of machines, all included in one center, requires the entire time of one foreman, the wages paid this foreman would be included with the other expenses in arriving at the total cost of operating the centers. The distribution of the power charge can best be made on the basis of the horsepower required by each production center. In this power charge we would include the expense of running the power plant as well as the shafting, belting, etc.

The expenses under consideration should cover a period long enough to insure correct results, as well as a period of normal operations so that the results will represent the hourly cost of operating the production centers in normal times and under normal conditions. The best results are obtained if the expenses for a whole year are used as a basis for the machine-hour rate; and if these expenses are carefully analyzed and allocated to the various production centers, the hourly rates first determined will not require much adjustment. In fact, the success or failure of the system depends on the amount of attention given to the division of the expenses at the beginning, as, unless the first rates are approximately correct, the first results obtained from the system will be so disappointing and misleading as to cause a manufacturer to condemn it and to insist for all time that the plan is no good. In this article we will assume that the expenses analyzed cover a period of one year.

Determination of Hourly Charge

Two groups of the annual expenses are now divided among the various production centers, and by adding the rental charges and the charges for operating and maintaining the machines, we have the basis for determining the hourly cost of expense applicable to work on the machine-hour basis. To determine the hourly charge, the total normal hours which each production center will work per year is estimated; then the amount of the expenses allocated to each production center is divided by the normal hours this center should operate, and the result is expense cost per hour.

There still remain a few items of expense which have not been distributed, such as supervision, clerical, and general administrative expenses. These expenses should be totaled, and the total divided by the sum of the normal hours of all the production centers. The result of this is another hourly expense cost which must be added to each machine rate as a supplementary charge.

Attention is called to the fact that the machine-hour rate is based entirely on the assumption that the production centers will work a certain number of hours in a certain time, a year having been used as the basis. It is obvious that no man can predetermine accurately the number of hours any machine in his plant will be occupied, and many people reject the idea of installing this system for that reason alone. However, a close approximation of the normal working time of any machine can be found, either by keeping records or examining records already available, and if the expenses of operating the machine are based on an approximately correct operating time, we have, by the machine-hour rate method, a means of showing immediately the financial effect of any variation of the operating time of the machines from the predetermined normal or standard operating time.

In making up the hourly rates, we assumed that we had a certain amount of expense, say $1200, to absorb in a certain period, say one year, over one production center. Let us say that we estimated the normal hours that this center would be used in the year to be 2400, or 200 per month. On this basis, the hourly expense cost of operating this production center is fifty cents. By adding fifty cents for each hour that a job required the facilities of this production center, we would expect to absorb all the expenses connected with it. Now, if the jobs passing through this center in a month required the use of the facilities for only 180 hours, we would see at the end of the month that on this particular center we had failed to absorb $10 of our expenses. We would have the same information for all other centers and, therefore, for the whole shop, and would know at the end of the month how much of the manufacturing facilities had not been used or had been used more than we expected, this information being available both in terms of hours and money. It is not, of course, expected that any manufacturer would absorb all of the difference between the amount of expense actually absorbed and the amount he expected to absorb, and to insure that all expenses are included in cost, a supplementary charge is made to each job to liquidate the amount of expense that has not actually been absorbed through the machine rates in use. This supplementary rate is a part of this system of expense distribution and is, in fact, a valuable factor because we know from the amount we add to the cost to absorb these supplemental charges, how far from normal the plant is running. In fact, one of the great benefits of this system is that the supplementary rate soon shows if machines are idle, because the expenses that would be absorbed by machines having work to do become, when these machines are not in use, a part of the supplementary charges, and the fluctuations in the monthly amounts liquidated by means of this charge show to a great extent the efficiency with which the facilities of the plant are being used. It will be evident that the machine-hour rate method permits of a very close knowledge and control of overhead expenses, and that by this system actual costs of each job can be obtained.

When comparing the way in which expenses are distributed by machine-rate costs with the distribution by means of any other method, it will be seen that, as far as accuracy is concerned, everything is in favor of the machine-rate method. All other methods of absorbing manufacturing expense depend in one way or another on averages, and yet there is no more reason for averaging the expenses over costs of all the work produced than there is for averaging the material items.

* * *

The report of a French commission states that the water power resources of France are calculated to be about 9,000,000 horsepower, and of this amount approximately 1,165,000 horsepower is being used. At present, equipment is being installed for obtaining an additional energy of about 500,000 horsepower. Plans are also being made for developing 3,000,000 horsepower additional in the next fifteen years.

RAPID DRILLING RECORDS

Whitman & Barnes "Hercules" high-speed twist drills established what is claimed to be the new world's production and penetration records in steel and cast iron at the Foundrymen's Convention, Columbus, Ohio, in October. The accompanying table gives the records attained, and indicates the excessive strains that these drills will withstand. The production record established by the 2-inch drill in drilling machine steel was made after 15 holes had been drilled through cast iron 3½ inches thick at 309 revolutions per minute with a feed of 0.096 inch per revolution. Therefore, with only one grinding this drill produced a total of 43 holes.

RAPID DRILLING DATA

Production Records

Size of Drill, Inches	R.P.M. of Drill	Feed per Rev., Inch	Penetration per Min., Inches	Thickness of Material, Inches	Time per Hole, Seconds	No. Holes Drilled per Grinding
Cast Iron						
1	665	0.096	63.8	3½	3¼	61
1⅛	309	0.060	18.5	4¼	13¾	303
Machine Steel						
2	157	0.045	7.1	3	25½	28
0.50 Per Cent Carbon Chrome-nickel Steel						
1	309	0.030	9.3	3	19 1/3	72

Penetration Records

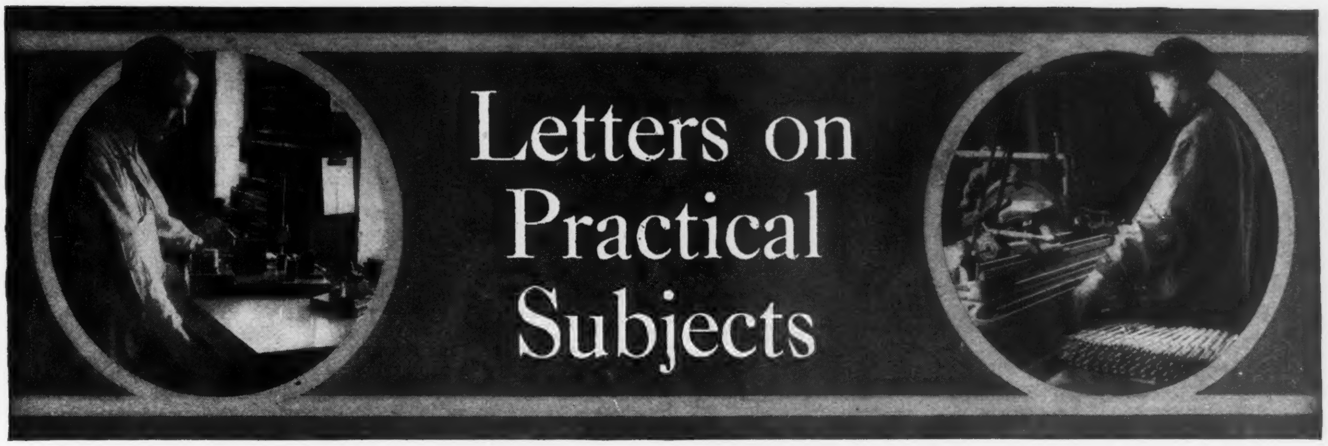
Size of Drill, Inches	R.P.M. of Drill	Feed per Rev., Inch	Penetration per Min., Inches	Size of Drill, Inches	R.P.M. of Drill	Feed per Rev., Inch	Penetration per Min., Inches
Cast Iron				Machine Steel			
⅞	873	0.096	83.8	1	665	0.060	39.9
1	873	0.096	83.8	1¼	442	0.060	26.5
2	597	0.096	57.3	1½	442	0.051	22.5

Machinery

* * *

IMPROVEMENT IN MOVEMENT OF FREIGHT

Encouraging evidence of the progress being made by the railroads in their efforts to speed up the movement of freight is found in a recent report of the Bureau of Railway Economics, which shows that the mileage made by the average freight car per day during the month of July was 26.1; this represented an increase of two miles per car per day over the corresponding month in 1919, and was the greatest mileage made since the month of October, 1919. For June the average was 25, and for each month of this year for which the figures have been compiled, there has been an improvement, both as compared with the preceding month and as compared with the corresponding month of last year, with the exception of April, when the switchmen's strike was at its height. An improvement of one mile in the average is equivalent to an addition of 100,000 cars to the freight equipment of the country. The report also shows that the average number of tons of freight per loaded car in July was 29.6, which was the greatest number for any month since December, 1918, when the average was 29.8 tons. For July, 1919 the average was 27.8 and for June of this year it was 29. These figures explain in part how the railroads have been able to handle the increased freight traffic in spite of inadequate facilities and labor difficulties.



Letters on Practical Subjects

LOCATING WORK FOR ACCURATE BORING ON MILLING MACHINES

It is often desirable to perform boring operations on milling machines, particularly on jig and fixture work where a high degree of accuracy is required. There is considerable variety in the methods which toolmakers employ on such machines for locating holes on finished and rough surfaces within the prescribed limits of accuracy. However, the writer has found the method here described the best and quickest that he has ever tried. This method gives accurate results, regardless of whether the milling machine is in a good or bad condition, the necessary adjustments of the work in both vertical and horizontal directions being made by an inside micrometer and several stops attached to the machine.

In order to locate the work horizontally, a stop is attached to the front of the table saddle and another is mounted on the front of the table. Then, when the machine has been set for finishing one hole, the distance between the two stops is measured by means of the micrometer. When it is necessary to adjust the table for machining another hole, the horizontal distance between the two holes is determined by calculation and this amount is either added or subtracted, as the case may be, from the distance to which the micrometer has previously been set. The micrometer is then reset to this new dimension, and the table shifted until the micrometer just fits between the two stops. Vertical settings of the work are obtained in a similar manner by using the micrometer between the top of the knee and a stop attached to the front of the column. A specific example will be presented to permit a clear understanding of the procedure.

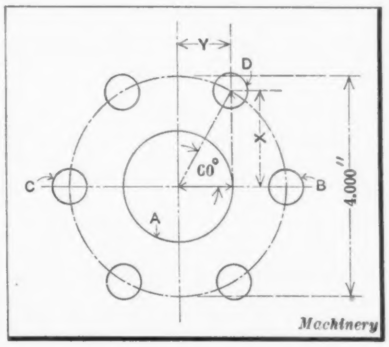


Fig. 1. Lay-out of Holes bored in Jig

Fig. 1 shows a lay-out of seven holes which were bored in a number of jigs of a certain type. Hole *A* was machined first, the other holes being located from it by the method outlined in the foregoing. Fig. 2 illustrates the method of locating the work horizontally for each of the holes. It will be seen that stop *A* is attached to the saddle and another stop *B* mounted on the table, while the inside micrometer *C* is shown in position between the two. When the table was set for boring hole *A*, Fig. 1, the reading of the micrometer was 11.668 inches. The next hole in the group to be bored was hole *B*, the distance between the center of this hole and that previously machined being 2 inches. Thus the micrometer was set to 13.668 inches and the table moved until the micrometer fitted between the two stops. In setting the table for boring hole *C*, the micrometer was set to 9.668 inches.

It is considerably more work to set the table for boring hole *D*; first it is necessary to calculate the horizontal and vertical distances between the center of this hole and that of hole *A*. Distance *Y* was calculated to be 1.000 inch, so that the micrometer was set to a dimension equivalent to 11.668 + 1 or 12.668 inches, and the horizontal setting of the table made as formerly. The distance *X* was calculated to be 1.732 inches which meant that the table had to be lowered that amount in order to bring the center of hole *D* in line with the spindle. Fig. 3 shows the application of the micrometer in this step of the operation, it being placed between the knee and stop *A* on the column. When hole *A*, Fig. 1, was being bored, the reading of the micrometer when placed between the knee and this stop, was 14.252 inches. Therefore, in locating the work for boring hole *D*, the micrometer was set to 14.252 + 1.732 or 15.984 inches, and the knee lowered until the micrometer fitted between it and the stop.

It is unnecessary to describe in detail the procedure followed in boring the remaining holes, as this should be apparent from the foregoing. Fig. 4 shows four jigs which

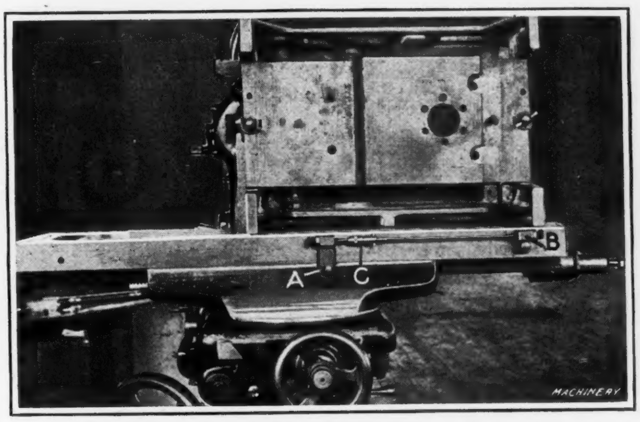


Fig. 2. Application of Inside Micrometer and Stops for locating Work horizontally

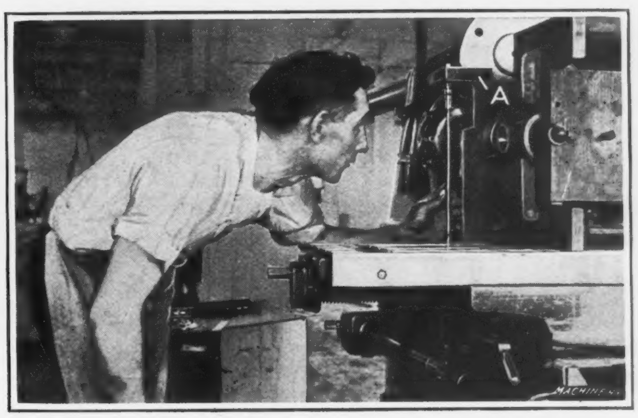


Fig. 3. Method followed in adjusting Table vertically for boring Holes in Work

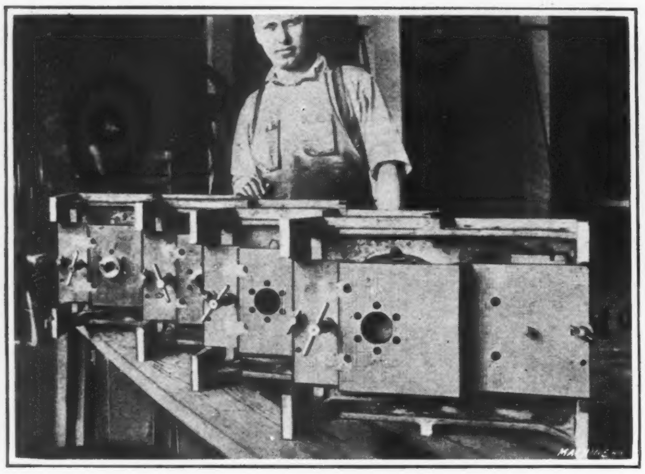


Fig. 4. Four Jigs having Holes machined within Tolerances of 0.0005 Inch by the Method described

were machined by the method described in the foregoing. The holes that were bored in these jigs were located within tolerances of 0.0005 inch.

Pittsburg, Pa. JOSEPH BOLKOVAC

A CASE OF FALSE ECONOMY

The writer recently observed an incident which occasioned surprise as to the readiness with which men jump at conclusions when endeavoring to reduce operating costs. Many inaugurate systems which apparently result in increased production, but which really produce the opposite effect. The following incident will serve to make this statement clear. One of the jobs in a certain shop consisted of punching broad flat stock wound on reels. Two operations were required to complete the work. In the first operation the stock was fed through a punch press and wound on another reel, the operation being automatic. The stock was then fed through a second press and again wound on a reel. This method was followed until one of the workmen hit upon an idea which was readily approved by the management.

The two presses were then placed in alignment and operated at the same number of revolutions per minute so that the stock could be fed through the first press and then fed directly through the second press without necessitating the winding of the material on another reel. It was generally believed in the shop that this method produced a considerable saving. On first thought this might seem true, but the operating costs were actually increased instead of being decreased.

In the first place, all the adjustments needed on the presses and the setting of the dies for each job were made by the foreman of the department, because the services of a skilled workman were necessary for this work. Besides this, two operators were still required for the presses. It took fifteen minutes to set up each press, and under the new system the first press, after having been set up, had to stand idle while the second press was being set up. Thus, there was a dead loss of fifteen minutes over the old system, in which one of the presses would be working while the other was being set up. During operation, a five-minute shutdown was required every hour on each press to permit adjustments to be made. Again, both presses were idle when an adjustment was being made on either of them. Thus, the time lost in making adjustments was twice that obtained when the two presses were operated independently, and so there was a dead loss of ten minutes per hour over the old system. Therefore, it will be seen that the loss over the old system amounted to fifteen minutes for setting up the machines for each job and ten minutes per hour during the performance of the operation.

The advantage of the old system over the new was, of course, due to the fact that one of the presses would continue running when the other was stopped. The fact that the two presses were operated simultaneously on the same job was perhaps responsible for the illusion that a saving would be realized by the new system, it being overlooked that the cost of operating two presses for one-half hour would be the same as the cost of operating one press for one hour. The disadvantages of the new system soon became apparent.

Philadelphia, Pa. R. H. KASPER

GRINDING-WHEEL SPINDLES

Grinding-wheel spindles such as are employed for ordinary grinding operations are usually unsuited for the various precision grinding operations required in the manufacture of ball bearings. For instance, the grinding-wheel spindle of an oscillating grinding machine used for finish-grinding ball races generally runs at a higher speed than that of an ordinary surface or cylindrical grinder, and at the same time must be so designed that all end thrust will be effectively taken up. The oscillatory motion imparted to the work produces an end thrust on the spindle, first in one direction and then in the other, due to the reversal of the direction of feed which takes place at each end of the stroke. The provision of suitable means for taking up the end thrust is therefore quite a problem in itself. Spindles of various designs have been developed and considerable time has been devoted to the study of this subject by the designers of ball-bearing manufacturing concerns.

The writer has made a personal study of the subject and although nothing new is claimed for the two designs here illustrated, which are the result of his efforts, they are offered as two examples of spindles which have given satisfactory results. No advantage is claimed for one type of spindle over the other. In Fig. 1 is shown one method of designing the wheel-spindle. In this case the spindle is made very heavy in order to prevent chattering. The end thrust on the spindle is taken up by the ball bearings at the ends. If the spindle were made light in weight, or about the same diameter throughout its length, as is generally the case, the high speed of rotation in combination with the thrust resulting from the reversal of the feed stroke would set up a certain amount of vibration which would be detrimental to the quality of finish required in the ball race of a high-grade bearing.

Spindle *D* is made of machine steel, casehardened on the ends, and ground all over. The ball race is also ground as a part of the spindle to insure a higher degree of concentricity than could be obtained by mounting an ordinary ball bearing on the spindle. The balls for the bearing are carefully selected, and the cups at the ends that support the spindle are made of tool steel, and are hardened and ground all over. The cups are a push fit in housing *A* and are adjusted by means of nuts *B* and set by means of screws *C*. The housing is made of cast iron, machined all over, and mounted in the spindle head.

In Fig. 2 is shown another type of spindle. A few more parts are required in the mounting of this spindle, and the

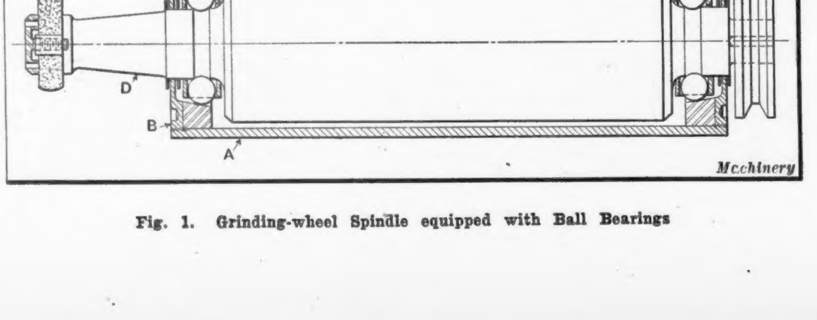


Fig. 1. Grinding-wheel Spindle equipped with Ball Bearings

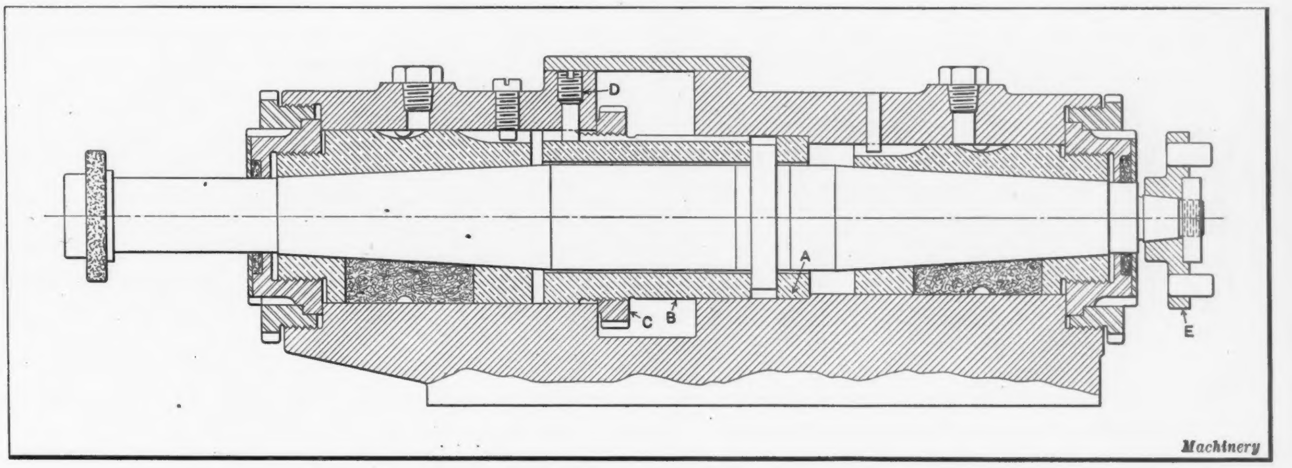


Fig. 2. Grinding-wheel Spindle equipped with Adjustable Taper Bearings

cost of making it is therefore greater. From the illustration it will be seen that the end thrust of the wheel is taken up by washer *A* and screw bushing *B*, which can be adjusted by nut *C* and locked by screw *D*. The end bearings and journals are tapered so that the bearings can be adjusted for wear without employing the usual split bushing. The objection to a split bushing is that it seems to have a tendency to warp when the spindle becomes slightly overheated, resulting in an increase in friction.

New York City CHARLES RUIZ

ATTACHMENT FOR MACHINIST'S SCALE

A scale provided with an attachment that makes it suitable for use as an inside caliper in measuring the diameter of large holes is shown in the illustration. The attachment can be placed on a scale of any length and of various widths, clamp *A* being adjustable to suit the width of the scale. It will be noted that the over-all length of the attachment is 6 inches, and so in order to determine the distance from the measuring end of the attachment to the opposite end of the scale, it is only necessary to add that amount to the distance that the scale projects past the attached end of the device. Thus, in the illustration, the distance between the extreme ends of the attachment and scale is 8 inches. In setting the device for measuring a hole of a certain size, screw *B* is loosened until clamp *A* has been withdrawn sufficiently from the scale to permit it to be slid easily along the device. After the scale has been moved to the proper setting, it is clamped in place by again tightening screw *B*. The end of this screw in the clamp is provided with a groove into which extends a pin driven in a hole in the clamp and thus secures the clamp to the screw.

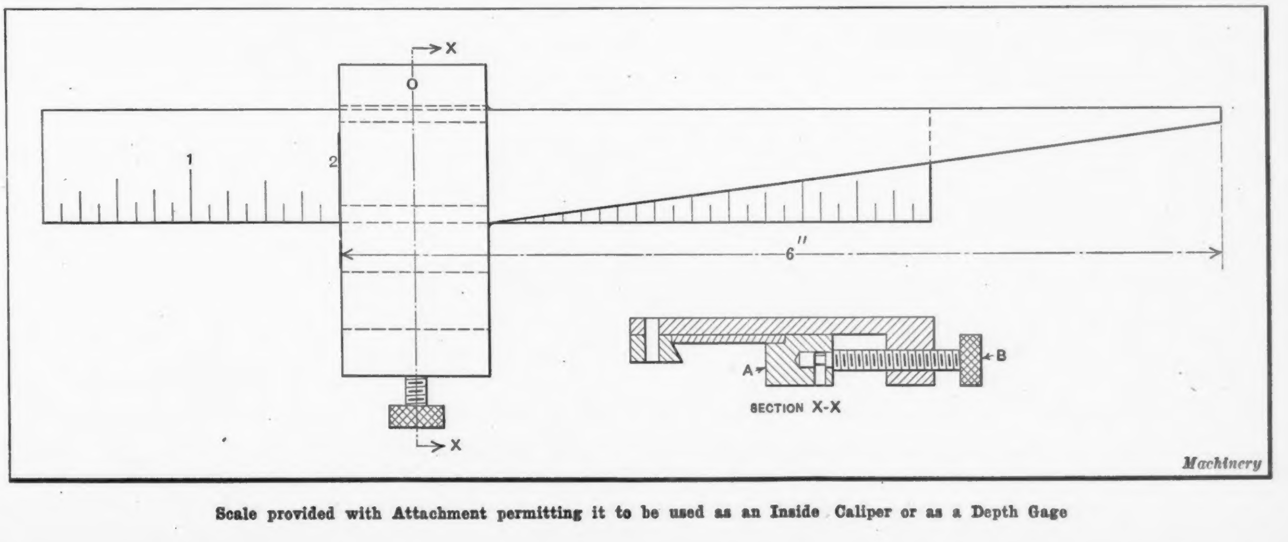
This tool is not so cumbersome as many types of inside calipers and after being set does not need to be handled with the care that large calipers require in order that their settings will not become altered. Accurate measurements can be taken, because the width of the scale causes the user to place it in the hole in the proper manner. It is obvious that the combined scale and attachment can also be used as a depth gage.

Montreal, Canada HARRY MOORE

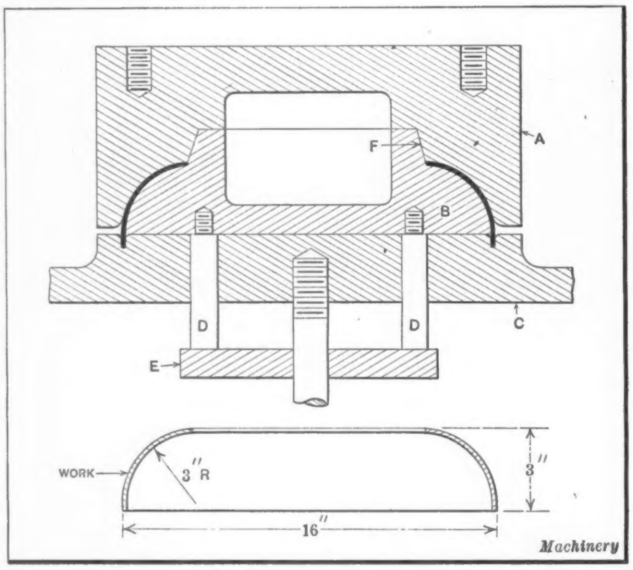
DIE FOR CURLING STOVE RINGS

Circular rings, such as are mounted on the tops of some stoves of the heater type for ornamental purposes, are bent or curled by means of the punch and die shown in the accompanying illustration. These rings are formed from flat steel strips 3⅜ inches wide and 0.065 inch thick, which are cut to the proper length. A drawing of a completed ring, giving adequate dimensions to convey an idea of its size, is shown beneath the die. The strip from which a ring is formed is first rolled so that the ends may be butted together or spot-welded and then ground to a uniform thickness. This produces a circular band, and the only function of the punch and die is to curl over the band as shown. Punch *A* and die parts *B* and *C* are made of cast iron, the punch and part *B* being cored out at the center to reduce their weight. It will be noted that the punch is not provided with a shank, as it is used on a large press and is attached to the end of the ram by machine screws.

On each return stroke of the punch, the curling die *B* is raised a distance of about 2⅞ inches by means of pins *D* and plate *E*, which is actuated by a rubber buffer. A band of strip metal is then slipped over the curling die and placed in the groove on the top surface of die-block *C*, the lower surface of die *B* being about ½ inch beneath the top edge of the band. Then, on the downward stroke of the press ram, the punch descends until the tapered surface in the



Scale provided with Attachment permitting it to be used as an Inside Caliper or as a Depth Gage



Punch and Die for producing Ornamental Rings for Stove Tops

opening of the punch makes contact with a corresponding surface on the curling die as shown at *F*, after which the two parts descend together and curl the ring as indicated.

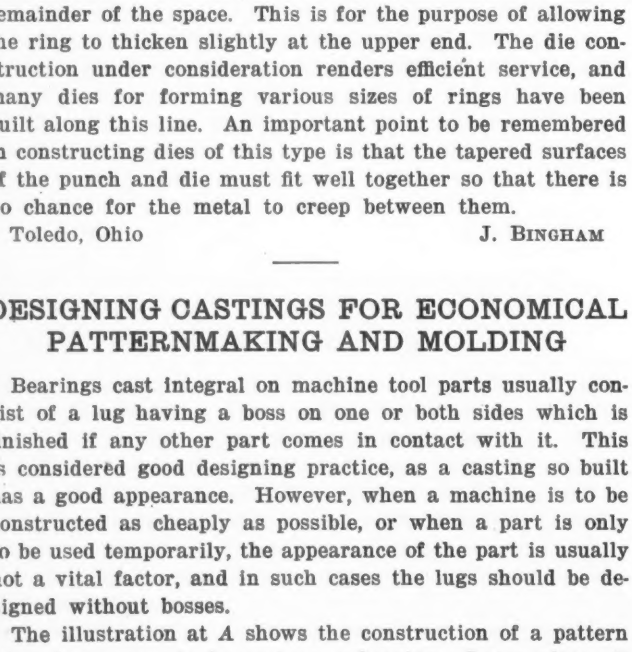
The pressure exerted by the buffer beneath plate *E* is sufficient to hold die *B* well against the punch during the downward stroke so that the metal of the ring is held to the desired thickness and the ring is properly formed. The top of the space between the punch *A* and die *B*, in which the ring becomes curled, is about 0.025 inch wider than the remainder of the space. This is for the purpose of allowing the ring to thicken slightly at the upper end. The die construction under consideration renders efficient service, and many dies for forming various sizes of rings have been built along this line. An important point to be remembered in constructing dies of this type is that the tapered surfaces of the punch and die must fit well together so that there is no chance for the metal to creep between them.

Toledo, Ohio J. BINGHAM

DESIGNING CASTINGS FOR ECONOMICAL PATTERNMAKING AND MOLDING

Bearings cast integral on machine tool parts usually consist of a lug having a boss on one or both sides which is finished if any other part comes in contact with it. This is considered good designing practice, as a casting so built has a good appearance. However, when a machine is to be constructed as cheaply as possible, or when a part is only to be used temporarily, the appearance of the part is usually not a vital factor, and in such cases the lugs should be designed without bosses.

The illustration at *A* shows the construction of a pattern when bosses are to be cast on a bearing. Loose pieces *C* are necessary to form the bosses in the mold; otherwise the mold would be destroyed when the pattern is withdrawn.



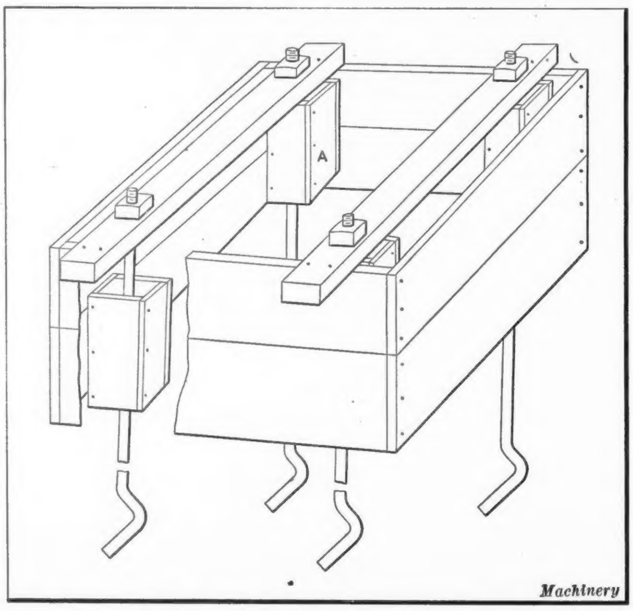
Two Methods of making Patterns for molding Bearings to be cast Integral with Part

These loose pieces are held in place by dowel-pins (not shown in the illustration). They are extracted by drawing them in and up through the mold, after the main pattern has been removed. When the drawing indicates that the hole through the bearing is to be cored, it is necessary to provide core-prints *D* to form pockets in the mold for supporting the required core. Unless the hole is large in diameter, it should not be cored, as unnecessary expense is involved in making the pattern and in molding the casting, and the machining operations are frequently made more difficult on account of the cored hole. When the hole does not need to be cored and when bosses are not required for appearance, the pattern can be built as shown at *B*. This construction permits a cheap pattern to be made and facilitates molding. The length of the bearing should be sufficient to allow the faces to be finished to the correct dimension.

Kenosha, Wis. M. E. DUGGAN

BOLTS FOR SECURING MACHINES TO CONCRETE FOUNDATIONS

Foundation or anchor bolts for fastening heavy machines to concrete foundations usually project a considerable distance above the floor line, and it is desirable to have them hang truly vertical in the hole provided for the foundation, before the concrete is poured. The illustration in the accompanying table shows a type of bolt which has proved satis-

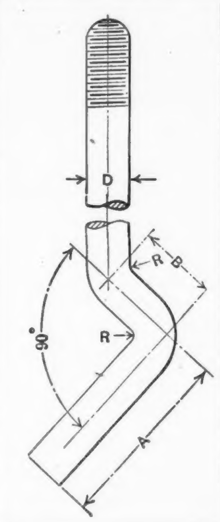


Method of locating and holding Foundation Bolts in Place

factory, its design permitting it to be readily forged and at the same time giving it good holding power. The table also gives the dimensions of the end of the bolt which is embedded in the concrete, for various sizes of stock.

The accompanying illustration shows the method of placing the bolts in the foundation hole, wooden strips being laid across the top of the concrete form for the purpose. These strips are provided with properly located holes through which the threaded ends of the bolts are inserted and from which they are kept from falling by means of nuts screwed on them. Obviously, the distance the bolts must project above the floor after the foundation has been completed, can be regulated by adjusting the position of the nuts. It is customary to provide pockets around the bolts near the top of the foundation so that the bolts can be bent sufficiently to permit them to enter the holes in the base of the machine when either the bolts or the holes are inaccurately spaced. These pockets can be formed by placing square sections made of light boards around the bolts as shown at *A*, the boards being sawed in such a manner that the grain in each of them will run in a vertical direction when they are nailed together.

DIMENSIONS OF FOUNDATION BOLTS IN INCHES



D	A	B	R
⅝	2⅞	1¼	5/32
¾	3 7/16	1½	3/16
⅞	4	1¾	7/32
1	4⅝	2	¼
1⅛	5 3/16	2¼	9/32
1¼	5¾	2½	5/16
1⅜	6 5/16	2¾	11/32
1½	6⅞	3	⅜
1¾	8 1/16	3½	7/16
2	9 3/16	4	½
2¼	10 5/16	4½	9/16
2½	11½	5	⅝
2¾	12⅝	5½	11/16
3	13 13/16	6	¾
3½	16 1/16	7	⅞
4	18⅜	8	1

Machinery

The sections do not require bottoms and can be nailed to the strips which support the foundation bolts. They can be easily removed when the concrete has hardened, and the pockets produced can be filled with a grouting mixture after the machine has been set in place.

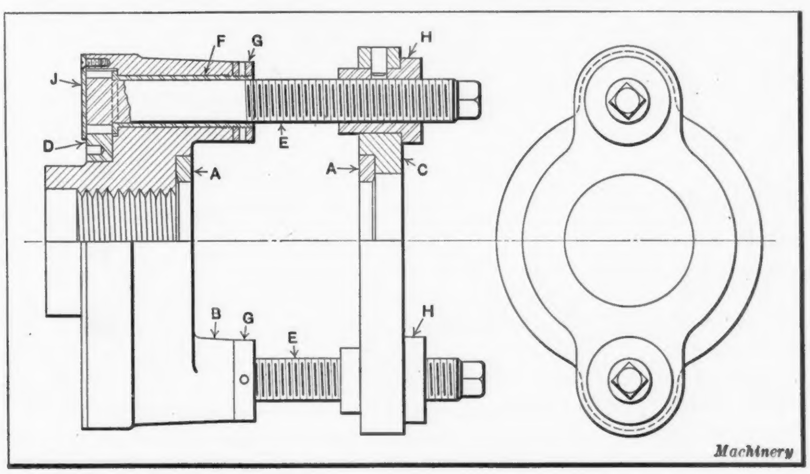
Watervliet, N. Y. M. H. Ball

CHUCK FOR INTERNAL GRINDING

A device permitting the rapid and accurate chucking of such work as bushings, circular cutters, hobs, etc., for internal grinding, is here illustrated. The ends of the part to be ground are located in the two hardened steel rings *A* that fit snugly into counterbored holes in the cast-iron body *B* and the movable yoke *C*. Body *B* is mounted on the spindle of the grinding machine, and is provided with a machined hub upon which a hardened ring gear *D* is fitted. The teeth of this gear mesh with the teeth of the pinions cut on the left-hand ends of screws *E*. Each of these screws rotates in a long tool-steel bushing *F* which is secured in place by means of nut *G*. Yoke *C* is provided with two hardened nuts *H* which are pinned to the yoke and are threaded to fit screws *E*. The chuck is operated by inserting the pins of a special wrench into holes in the face of gear *D* and then revolving the wrench slightly. This action turns the two screws in unison, and causes the nut and yoke to be moved either forward or backward, according to the direction in which the wrench is applied.

Proper care must be taken in assembling to adjust the nuts so that both ends of the yoke are equidistant from the body of the chuck. The holes in rings *A* are ground to a slight taper to take care of small variations in the diameter of the work, and the rings are under-cut on their inside faces to indicate which face is the inner one and to facilitate the removal of the ring in the counterbored hole in the body of the chuck. Screws *E* have square ends at the right so that they can be turned rapidly by means of a wrench when desiring to change the position of the yoke to suit longer or shorter work. A canvas cover is placed over the screws to prevent dirt or grinding dust from getting on them. The teeth of the pinions and ring gear are also completely covered by means of plate *J* which is screwed on the back of body *B*.

Chicago, Ill. Ralph R. Weddell



Chuck Suitable for Internal Grinding of Bushings, Cutters, Hobs, etc., which permits Rapid and Accurate Insertion and Removal of the Work

DETERMINING HEIGHT OF ARC WHEN MILLING KEYWAYS

When milling keyways it is often desirable to know the total depth from the outside of the shaft to the bottom of the keyway. With this depth known, the cutter can be fed down to the required depth without taking any measurements other than that indicated by the feed graduations on the machine. In order to determine the total depth, it is necessary to calculate the height of the arc, which is designated as dimension *A* in the accompanying illustration.

The formula usually employed to determine *A* for a given diameter of shaft *D* and width of key *W* is

$$A = \frac{D}{2} - \sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{W}{2}\right)^2}$$

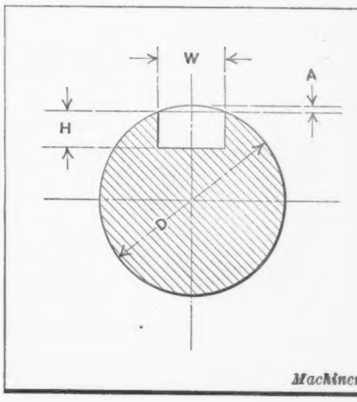


Diagram illustrating Method of determining Total Depth of Keyways

The values of *A* for shafts and keys of ordinary size, are given on page 499 in Machinery's Handbook. However, it sometimes happens that use is made of keyways or shafts of unusual size which are not included in the table, and in such cases the writer has found the following method of determining dimension *A* much simpler than the one first given. Using a table of trigonometric functions as arranged in Machinery's Handbook, the method is to apply the formula

$$A = \frac{D}{2} \times \text{versed sine of an angle whose cosecant} = \frac{D}{W}.$$

To illustrate the application of this formula, let it be required to find the height *A* when the shaft diameter *D* is ⅞ inch and the width *W* of the key is 7/32 inch. Then,

$$\frac{D}{W} = \frac{7/8}{7/32} = \frac{7}{8} \times \frac{32}{7} = 4$$

Now in a table of trigonometric functions, locate the value nearest 4 in the column headed "Cosecants," which is 3.9984. Next, in the column headed "Versed Sine," and on the same line with this cosecant, find the value 0.03178.

Then,

$$A = \frac{D}{2} \times 0.03178$$

$$= \frac{7 \times 0.03178}{8 \times 2} = 0.0139 \text{ inch}$$

The total depth of the keyway equals dimension *H* plus 0.0139 inch.

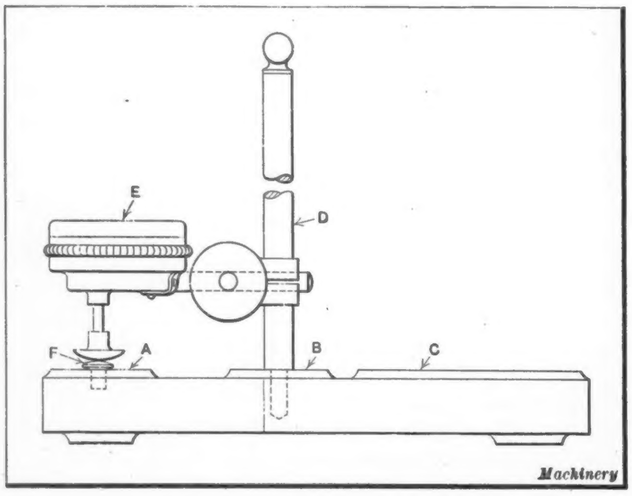
Anderson, Ind. C. W. Mapes

SHOP AND DRAFTING-ROOM KINKS

STAND FOR DIAL TEST INDICATOR

A dial test indicator makes a convenient thickness gage for sheet metal, wire, paper, etc., when clamped to a surface plate, so that the pieces to be gaged may be quickly slipped under the contact point and the readings taken direct. The accompanying illustration shows a stand especially constructed for a Starrett indicator which permits the dial indicator to be instantly removed for use elsewhere, if required. It consists of a cast-iron base with three feet cast on the bottom to form a steady three-point bearing. Three bosses, *A*, *B*, and *C* are cast on the top surface; boss *C* is rectangular and is given a surface-plate finish. The middle boss *B* is circular and serves as an insertion point for the vertical column *D* which supports the dial *E*. Boss *A* is circular and is drilled either to take one of the extra contact points *F*, sent with the indicator outfit, or a steel bearing ball about 1/4 inch in diameter. The steel column sent out with the indicator may be screwed into the base, but if a special one is made to serve permanently, the other may be used with the dial when it is required elsewhere.

In use, the dial may be set at any required height above the surface of boss *C* and swung around from the large boss over to the contact point *F* set in boss *A*. Wires and various other pieces may be gaged between the two points, while sheets of metal or paper can usually be gaged more easily by placing them on the surface of boss *C*. The apparatus may also be used as a limit gage by setting the dial to zero with a standard piece in place. The amount the parts vary in thickness below or above the standard may then be read off as they are pushed under the dial.

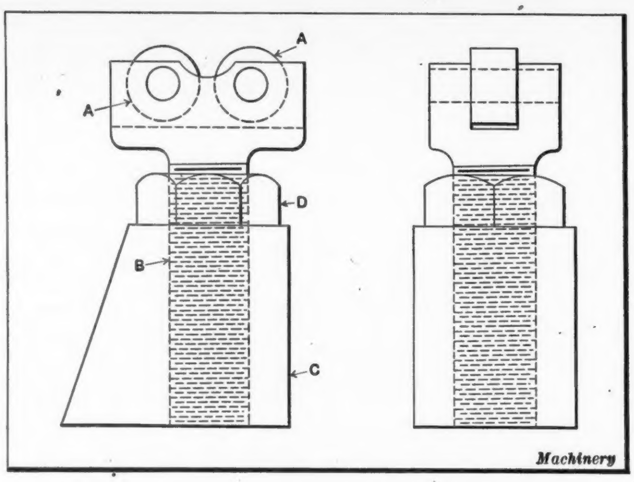


Stand with Surface Plate and Point Contact for Use with Dial Test Indicator

Oakland, Cal. H. H. Parker

ROLLER JACK FOR MILLING MACHINES

A screw jack having two rollers for supporting the work, which is especially suited for use on milling machines in connection with an indexing head, is shown in the accompanying illustration. The rollers *A* upon which the work rests are a loose fit on two pins which are driven into holes through the forked end of screw *B*. Base *C* is tapped to suit the screw, so that the distance from the bottom of the base to the top of the rollers can be adjusted to suit the work by revolving the screw. Nut *D* is screwed tight against the top of the base to prevent the screw from turning after the rollers have been set.



Screw Jack with Rollers for supporting the Work Suitable for Use on Milling Machines

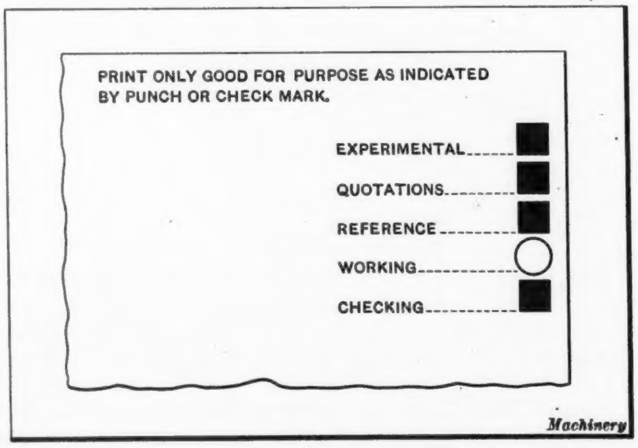
As this jack has two supporting points, it cannot tilt and throw the work out of position. The work is also better supported, and there is less chatter while it is being rotated. It is advisable to place a piece of paper between the work and the rollers to eliminate the danger of chips coming between them. The rollers are 9/16 inch in diameter and 3/8 inch thick, while screw *B* is 5/8 inch in diameter and has 18 U. S. form threads per inch. The rollers and screw are made of machine steel and are casehardened.

Los Angeles, Cal. E. F. Tuttle, Jr.

MARKING BLUEPRINTS TO INDICATE THEIR USE

It is customary in many drawing-rooms to employ rubber stamps for the purpose of marking blueprints so that the use for which they are intended may be readily understood. A better method of marking, which is utilized on standard tracings that have the title and border lines printed on the back, is to have a set of instructions also printed on the back at the same time and in the upper left-hand corner, as shown in the illustration. The purpose of the print is indicated by punching out the solid square opposite the word describing the purpose. Sometimes the same print can be used more than once; it may first be desired for experimental purposes, and when the part is ready for production, the print may be punched as a working drawing.

Warren, Ohio C. C. Spreen



Instructions printed on Tracing Cloth to indicate Use to which Print is to be put

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

CALCULATING THE OUTER RADIUS OF A HOLLOW SPHERE

C. E. B.—If the shell of a hollow iron ball is 4 inches thick, and contains one-fifth the cubical contents of the whole ball, how can the outer radius of the ball be found?

A.—Let R be the outer radius of the ball; then $R - 4$ will be the radius of the hollow sphere enclosed by the shell. As the volume of a sphere is proportional to the cube of its radius, the conditions of the problem are given by the equation:

$$R^3 - (R - 4)^3 = 1/5\ R^3$$

or

$$4/5\ R^3 = (R - 4)^3$$

Extracting the cube root, transposing, and combining,

$$R = \frac{4}{1 - \sqrt[3]{4/5}}$$

Since $4/5 = 8/10$ and 8 is a perfect cube, the above equation may be written

$$R = \frac{4\sqrt[3]{10}}{\sqrt[3]{10} - 2}$$

By reference to a table of cube roots the proper values can be easily ascertained, and then, by working out the formula, it will be found that $R = 55.80$ inches. W. W. J.

A GEOMETRICAL PROBLEM

H. K. D.—Will you please show how to find the radius x from the dimensions given in Fig. 1?

A.—From Fig. 1 we have the conditions shown in Fig. 2, from which the value of x can be found as follows:

In triangle ABC

$$\text{Cos } B = \frac{a^2 + c^2 - b^2}{2ac} \qquad (1)$$

In triangle OBC

$$\text{Cos } B = \frac{a^2 + m^2 - h^2}{2am} \qquad (2)$$

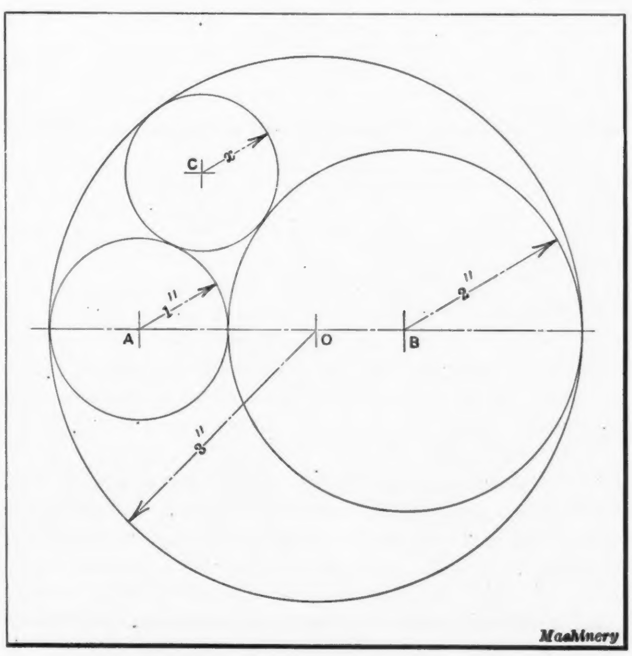


Fig. 1. Problem in which Dimension x is required

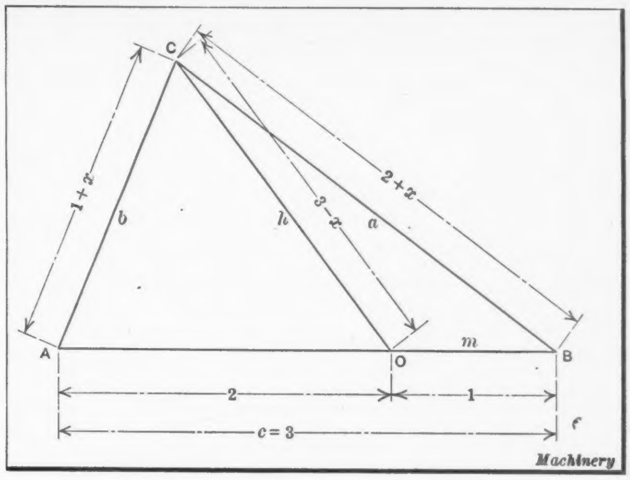


Fig. 2. Diagram illustrating Method of finding x Fig. 1

From (1) and (2) by comparison

$$m(a^2 + c^2 - b^2) = c(a^2 + m^2 - h^2)$$

or

$$m[a^2 + (c + b)(c - b)] = c[a^2 + (m + h)(m - h)] \qquad (3)$$

Let $a = 2 + x$, $b = 1 + x$, $c = 3$, $h = 3 - x$, and $m = 1$. Then

$$1[(2 + x)^2 + (4 + x)(2 - x)] =$$
$$3[(2 + x)^2 + (4 - x)(x - 2)]$$
$$12 + 2x = 3(10x - 4) \text{ or } 28x = 24$$
$$x = \frac{6}{7} = 0.857 \text{ inch}$$

W. W. J.

A MATHEMATICAL PROBLEM

P. P. H.—Referring to the accompanying diagram, can someone show how to find the distances x, x_1, y, and y_1, when $b = 1\frac{1}{4}$ inches, $r = 2\frac{1}{2}$ inches, and angle $P = 15$ degrees?

A.—Let O-X and O-Y be the axes of rectangular coordinates with O as the center. Then by analytical geometry, the equation of the line AC is,

$$x = y \tan P + b \qquad (1)$$

The value x_1 can be determined by substituting y_1 for y in this equation. Considering x as one-half the chord of a circle,

$$x = \sqrt{2ry - y^2} \qquad (2)$$

Since line AC and the circle intersect at B and C, they have common coordinates for the point of intersection, and the values of x may be equated as follows:

$$y \tan P + b = \sqrt{2ry - y^2}$$

By squaring, transposing and collecting terms, we get

$$y^2 (1 + \tan^2 P) - 2(r - b \tan P)\, y + b^2 = 0 \qquad (3)$$

But, as $1 + \tan^2 P = \sec^2 P$, Equation (3) may be written,

$$y^2 \sec^2 P - 2(r - b \tan P)\, y + b^2 = 0$$

Solving this quadratic equation for y,

$$y = \frac{r - b\tan P}{\sec^2 P} \pm \frac{\sqrt{(r - b\tan P + b\sec P)(r - b\tan P - b\sec P)}}{\sec^2 P} \qquad (4)$$

This equation gives two values for y; when it is used with the minus sign before the radical, the value for y is obtained, but when the plus sign is used, the value of y_1 is obtained.

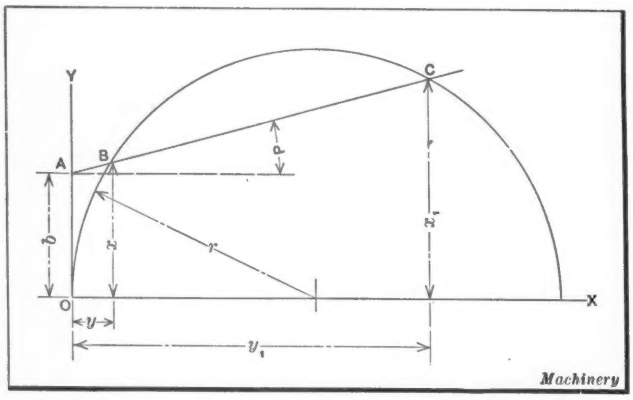


Diagram used in Solution of Mathematical Problem

Having found y and y_1, then x and x_1 may be found from Equation (1). Inserting the values of b, r, and P in Equation (4) and solving,

$$y = 0.4005 \text{ inch, and } y_1 = 3.6395 \text{ inches}$$

Substituting these values in Equation (1) and solving,

$$x = 1.3573 \text{ inches, and } x_1 = 2.2252 \text{ inches.}$$

W. W. J.

MATHEMATICAL PROBLEM

W. A. H.—Referring to the accompanying diagram, it is desired to find angle x when the lengths of lines E and D and the radius R are known.

ANSWERED BY HENRY DENOTTER, MUSKEGON, MICH.

Erect a perpendicular at F passing through point C, from which the arc is struck, and construct AB parallel with E, extending it to intersect the perpendicular. In the triangle ABC, side $AB = E$; and side $BC = D - R$

Therefore

$$AC = \sqrt{E^2 + (D - R)^2}$$

Then

$$\text{Tan } a = \frac{BC}{AB} = \frac{D - R}{E}$$

$$\text{Sin } b = \frac{R}{AC} = \frac{R}{\sqrt{E^2 + (D - R)^2}}$$

$$c = 90 \text{ degrees} - (a + b)$$

Hence,

$$x = 180 \text{ degrees} - (90 \text{ degrees} + c)$$

Example: If $D = 3.75$ inches, $R = 2.50$ inches, and $E = 5$ inches, then

$$\text{Tan } a = \frac{3.75 - 2.5}{5} = 0.25$$

$$a = 14 \text{ degrees } 2 \text{ minutes}$$

$$\text{Sin } b = \frac{2.5}{\sqrt{5^2 + (3.75 - 2.5)^2}} = 0.48507$$

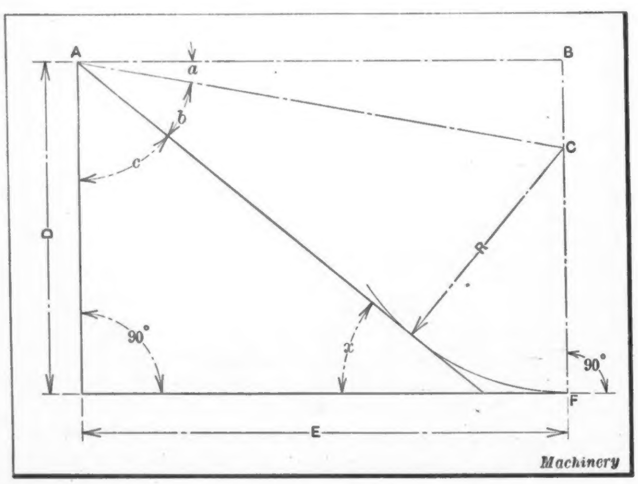


Diagram used in Solution of Mathematical Problem

$$b = 29 \text{ degrees } 1 \text{ minute}$$

$$c = 90 \text{ deg.} - (14 \text{ deg. } 2 \text{ min.} + 29 \text{ deg. } 1 \text{ min.})$$
$$= 46 \text{ degrees } 57 \text{ minutes}$$

Therefore,

$$x = 180 \text{ deg.} - (90 \text{ deg.} + 46 \text{ deg. } 57 \text{ min.})$$
$$= 43 \text{ degrees } 3 \text{ minutes}$$

DETERMINING THE CENTER OF GRAVITY OF AN ODD SECTION

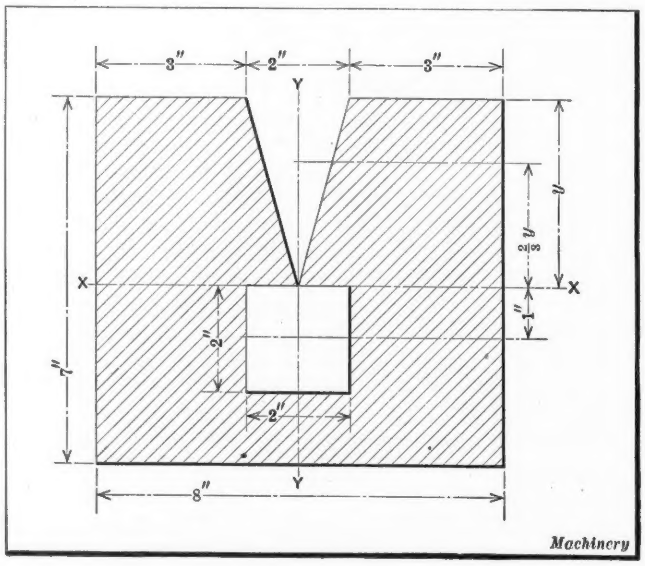
L. E. S.—Referring to the accompanying illustration, can anyone give an algebraic equation for finding the required depth of the V-notch so that its point and the upper edge of the square hole will lie on line X–X passing through the center of gravity of the section.

A.—A formula for determining the desired dimension y was evolved by the writer in the following manner: First, divide the section into elementary rectangles and triangles, the areas and centers of gravity of which can easily be found. The center of gravity of the triangle which forms the V-notch is two-thirds the length of the perpendicular distance y from axis X–X. Then, since the section is symmetrical about axis Y–Y, and the center of gravity lies on axis X–X, the center of gravity will be at the point of the V-notch, and the algebraic sum of the moments of the elementary areas about axis X–X will be equal.

Thus,

$$(8y)\left(\frac{y}{2}\right) - \left(\frac{2y}{2}\right)\left(\frac{2}{3}\,y\right) = 8\,(7 - y)\left(\frac{7-y}{2}\right) - (1 \times 4)$$

Clearing of fractions and combining terms, the following quadratic equation is obtained:



Section having the Point of the V-notch and Upper Edge of the Hole along an Axis through the Center of Gravity

$$y^2 - 84y + 288 = 0$$

which may be written

$$y^2 - 2(42)y + 288 = 0$$

Solving this quadratic equation,

$$y = 42 \pm 6\sqrt{41}$$

Using the equation with the minus sign before the radical, $y = 42 - 38.419 = 3.581$ inches, which is the depth of the V-notch.

W. W. J.

* * *

When repairs are being made on a machine, all possibility ot the machine being started without the knowledge of the person making the repairs should be eliminated. One method of doing this is to lock the switch, clutch, valve, starting lever, or other starting device by means of a padlock and short piece of chain or rope. Similarly, all inlet control valves of boilers, gas tanks, acid vats, etc., should be locked when it is necessary for a man to enter them.

Electro-deposition of Iron in Automobile Repair Work

BY a process developed in England during the war, it is possible to deposit a layer of iron up to approximately 0.08 inch in thickness on any simple cylindrical surface of wrought iron or steel. The process was described by B. H. Thomas before the British Institution of Automobile Engineers. If properly done, the layer deposited is firmly adherent, and it is practically impossible to chip it away from the basic metal with hammer and chisel. It is deposited directly on the surface without coppering first, and can be subjected to red heat without apparent deterioration. It can be carburized and hardened in the ordinary way, and when thus treated under favorable conditions, it appears to associate itself so closely with the basic material that the dividing line shown in photomicrographs of the untreated deposit passes away. The layer presents an extremely smooth surface, and the thickness deposited in a given time can be predicted with considerable accuracy.

The layer can be filed or ground and takes a high finish. Its wearing qualities are perfectly satisfactory on such parts as the ends of brake and clutch shafts which wear considerably in their brackets, and there is no obvious reason why the process would not be satisfactory for building up worn journals. Its chief limitation has been the inability to deposit satisfactorily on such materials as cast iron or aluminum. This is regrettable, because if it were possible to deposit an adherent coating of iron on such parts as worn ball-race housings in gear-boxes, the scope and usefulness of the process would be greatly increased. It is possible to deposit copper on aluminum parts, but such deposits are never permanently adherent. The practice of putting on a copper deposit which will not adhere is not worth while, as the same end is achieved more easily by simply coppering the outside of the ball races where necessary. This has the disadvantage of rendering such parts non-standard, but in many cases it is the only way of saving a part, and is preferable to tinning or knurling.

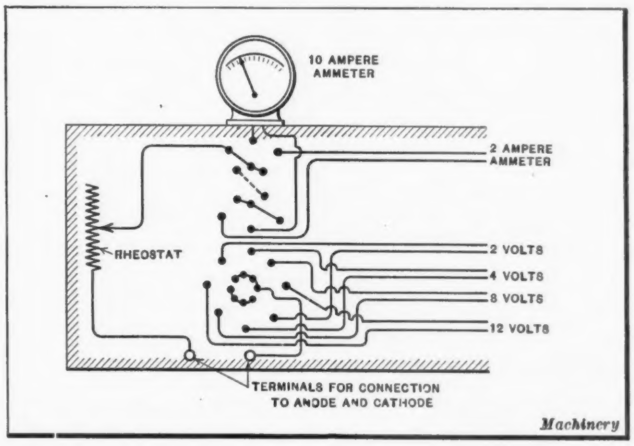


Diagram showing the Electric Wiring of a Depositing Bench

Types of Work Built up by Electro-deposition

Over 6000 parts have been reclaimed by the process to be described, some of which are as follows: Steering spindles on front axles; steering-spindle pins; brake and clutch shaft ends; gear-shift lever shafts; wheel hubs, where the housings have worn loose on the ball races; various shafts, on which ball races are required to fit, including magneto armature shafts; tubular axles, where worn in the saddle brackets; and universal joint pins. In many cases an automobile that has had parts reclaimed in this manner has been returned to the shops after a sufficient period of use to make a complete overhaul again necessary, and it has been possible to examine the wear of deposits under severe conditions. Such examinations have shown that the deposited parts stand up well in service.

The following is a list of the equipment contained in an actual electro-deposition shop in England: Depositing benches: Two double benches, having batteries of 12 vats per side, giving a total of 48 vats; and one bench with a large separate vat for simple repetition work, such as quantities of pins and bushings. Machine tools: One universal internal and external grinder; one thread-cutting lathe having a distance of 6 inches between centers; one polishing machine; and one electric drill. Miscellaneous: One earthenware sink with drain; two large cleaning vats fitted for electrolytic cleaning; one extra large vat for decantation of the iron solution; two steam-heated wax containers; one set of fine chemists' scales; one set of graduated beakers; one burette for titration; one set of internal and external micrometers; three ¼-horsepower electric motors for rocking anodes; one set of accumulators coupled in groups for 12, 8, 4, and 2 volts, and arranged for charging; and instrument boards, rheostats, vises, small tools, etc.

Details of Depositing Bench

The essential parts of a depositing bench are as follows: A double-pole four-way switch, for obtaining currents of 2, 4, 8, and 12 volts; a double-pole three-way switch for supplying current to the bath, through a 2- or a 10-ampere ammeter; an adjustable rheostat; a clock face for recording the hour when work is put on or taken off; plugs and sockets for recording the day that work is put on or taken off; an ammeter; a cross-shaft carrying rocker arms with anodes; an adjustable holder for the work; a wooden depositing vat, pitch lined; and terminals for connecting to the bath. The cross-shaft receives its motion through an eccentric driven by means of a ¼-horsepower electric motor and reduction gearing. The accompanying illustration shows diagrammatically the wiring of a depositing bench.

Cleaning and Preparing Work for Operation

It should be understood clearly that the process to be described refers to direct deposition; that is, without any intermediate copper coating. It was found essential to provide means for keeping the shop at a reasonably even temperature, as otherwise in cold weather the deposits became brittle and would not adhere. Therefore, a steam heating system was installed and kept in operation night and day when necessary. The efficient cleaning of the work is naturally of the highest importance, and is, indeed, almost the crux of the whole process.

This cleaning may be divided into seven stages: (1) The work is washed by gasoline to remove the coating of oil or grease that it usually has when brought to the shop. (2) The work is boiled in a caustic soda solution consisting of 1¾ avoirdupois ounces of caustic soda, 1¾ ounces of washing soda, and about 1 quart of water. The temperature of this bath is approximately 194 degrees F. This operation takes about twelve hours. Attempts to improve the action of the bath by making it electrolytic were inconclusive. (3) After rinsing off the caustic soda, the work is cleaned as

thoroughly as possible by means of scratch brushes. The portions not to be deposited on, are waxed after this step. (4) The work is again washed with gasoline after which, if it cannot be passed straight to the depositing bench, it is covered with a protecting coat of organic grease consisting of 50 per cent tallow and 50 per cent linseed oil. (5) After wiping off the grease put on the work in the preceding step, it is made the cathode in another soda bath similar to that used in the second step, but at the normal room temperature. A current of 30 to 50 amperes is applied for three minutes, using a sheet-iron anode. The fluid film left on the work after this operation should not be permitted to dry; the work should be washed in running water and put through the next step. (6) The work is made the anode in an electrolytic acid bath consisting of 25 per cent sulphuric acid and 75 per cent water. A current of from 30 to 60 amperes is applied for several minutes. (7) Where extra firm adhesion is required, an acid dip is preferable prior to the sixth step, as photomicrographs show that when a surface is eroded there is a better opportunity for the deposit to interlock with the basic material. The composition of the dip used is 50 per cent nitric acid and 50 per cent water. After the work has been placed in this bath for several seconds it will be covered with a black slime, presumably free carbon. This will clean off easily in the electrolytic bath to which the work is submitted in the sixth step.

The exact manipulation of the bath in the sixth step, depends greatly on the class and condition of the work. If it is much pitted with rust or scores which are not cleaned up within three minutes or so, the current may be reversed for another three minutes. Finally, the current is again reversed; this usually suffices to produce a fine white mat surface. There are a number of precautions that must be taken in connection with this bath: It must be changed frequently, as the metal dissolved appears to hinder the action, even though the acid may still be fairly strong, and the amount of sulphate in solution small; the solution should not be stirred, nor the work moved while the current is turned on; the anode and cathode should be separated by means of a porous screen to prevent the gas given off from the cathode from disturbing the acid around the anode; when the work is clean, the current should be switched off, the work removed and rinsed in running water as rapidly as possible, and then transferred at once to the depositing bath; as a rule a current density below 7 square centimeters per ampere is not satisfactory; the cleaning effect seems to be largely dependent on the free gassing at the anode; and the temperature of the bath should be kept low.

Waxing the Work

Where part of a surface is to remain unaltered, it is necessary to cover it with wax or some other composition, as mentioned after the third step in the cleaning process. Either of the following compositions has been found satisfactory in practice: Beeswax, 90 per cent; resin, 7 per cent; and boiled linseed oil, 3 per cent; or bitumen, 70 per cent, and paraffine wax 30 per cent. There are two precautions to be taken in waxing the work: First, the work should be heated before applying the compound; and, second, too thick a coating of wax should not be applied and the edges should be finished off neatly. A copper-wire lead is next sweated to the work, and the latter is measured with a micrometer. A ticket is then made out to accompany the work to the next process. This ticket shows the thickness of the layer to be added, the finished diameter required, the total area to be deposited on, and the current necessary to give the prearranged density.

Deposition of the Iron Layer

The solution used in the deposition is ferrous ammonium sulphate having a strength of 2.5 avoirdupois ounces per quart of water, with a current density of 30 square centimeters per 0.1 ampere. The rate of deposition is a layer about 0.0002 inch thick per hour. The operation is performed in separate vats having capacities of about 28 quarts.

The general method of operation is to suspend the work in a vertical position in the vat. This is accomplished by means of rods fixed to the bench, which are provided with arms having universal joints and fitted with clamps at the end to hold the work. The anode is then suspended from the rocker arm and made to surround the work concentrically, as, especially with thick deposits, it is important to keep the anode equidistant from the work at all points so that the deposit will be uniform in thickness.

The anodes are made of Swedish iron of about No. 16 British Imperial wire gage, thoroughly annealed, and wound into the form of a woven cylinder. They are suspended and stiffened by means of a 1/4-inch iron rod on one side, which is attached at the top to the rocker arm. The anodes are also fitted with two celluloid cones to produce an upward pumping action, the effect of this action being essential to avoid having a stagnant solution in contact with the work. It also keeps the ferrous carbonate in the solution in a state of suspension. The anodes should be kept clean by scrubbing off the black slime which tends to collect.

After completing the cleaning processes already described, the work is transferred to the depositing vat as rapidly as possible, and electrical contact made at once. It is important to immerse the work before the water film from the last cleaning step is dry, and to start the current at once. The current is adjusted to the prearranged value by means of the variable voltage switches and the adjustable rheostat provided. Either of the two ameters can be put in circuit with each separate vat at will. The more delicate of the two reads 2 amperes by 0.05 ampere.

The constancy of the current is a matter of supreme importance; so it is essential that the source of supply and the electrical arrangements be entirely satisfactory, and the current value checked frequently. It should be remembered that some work may be on the bench for two weeks, though most jobs only average one or two days. With careful treatment long jobs have been found when finished to be within 2 1/2 per cent of the calculated thickness.

Acidity and Current Density of Solution

From the results of experiments, it was decided that the most satisfactory method was to work the solution as nearly neutral as possible, and to keep the current density down to 30 square centimeters per 0.1 ampere for all thick deposits. The solution always tends to become acid, and when this occurs it has been found that the deposit becomes hard, bright, brittle and non-adherent, or badly pitted. In order to reduce the acid content, freshly prepared and well-washed ferrous carbonate should be added from time to time. The determining factor in the process is the personal equation; an inefficient operator will make little or nothing of it, while in skilled hands the process yields valuable results.

Causes of Failure in Process

Some of the most common defects met with in this process and their causes will be considered in the following: Bad adherence; this is usually due to faulty cleaning, acidity of the solution, and having the temperature of the solution too low. Roughness; this results from a lack of efficient agitation of the anode; foreign matter in the iron solution due to dirt and dust from the atmosphere and infrequent decantation; and too high a current density. Brittleness and splitting of the deposit, and pitting; these result from acidity of the solution and too low a temperature. Excessive banking at the edges; this is due to too much agitation of the anode, and too high a current density. Tree growths; these also result from too high a current density, and foreign matter in the solution. Layers or concentric strata; these are apparently due to interruption or excessive variation of current density. Finally, excessive departure from the calculated rate of deposit; this results from the variation of current density and from the formation of tree growths, which absorb a portion of the energy of the bath.

Aluminum Alloys

THE phenomena of the growth and aging of parts made from aluminum alloys, the effect on the physical properties of aluminum when it is alloyed, the physical properties of an aluminum forging alloy, and the conclusions arrived at when aluminum was compared with other metals were discussed in a paper presented before the Detroit section of the Society of Automotive Engineers, by Zay Jeffries, research director of the Aluminum Manufacturers, Inc., Cleveland, Ohio. With respect to the growth and aging of aluminum alloys, it was stated that no matter how the alloy is cooled in ordinary methods of production, a permanent change of volume takes place when it is reheated to a temperature of about 572 degrees F. This permanent change of volume was found in all the commercial alloys of aluminum studied by the writer, although it differed somewhat in magnitude.

The change in volume can be made permanent at the room temperature so that the casting will not grow any more. This change of volume first came to the attention of the writer in connection with racing automobile pistons, where the temperature had been so high that the pistons had actually increased in diameter. This is not an important factor in the ordinary water-cooled engine, because the temperature is seldom high enough to cause such a growth, except perhaps in the head where the clearance is ample to take care of it; but in air-cooled cylinders and in racing engines there is no question but that the pistons are susceptible to a certain amount of growth.

When aluminum alloys cool to room temperature they keep on changing in physical properties at that temperature. The standard No. 12 alloy when cast in sand, for example, has a certain tensile strength and elongation, but twenty-four hours after the casting, it has different properties. Its strength has increased slightly and its ductility has decreased slightly; after a few months the change is still more in the same direction. In one of the more ductile alloys a reduction in the elongation of from 8 per cent in the freshly cast alloy to 5 per cent after a month's aging, is sometimes found, while the tensile strength and elastic limit have increased. All the castings used in the last fifteen years have undergone this change, which is nearly complete in thirty days at ordinary room temperatures. No serious disadvantages have arisen, so that knowledge of the fact that these changes take place should not cause alarm. It may later lead to a more intelligent use of the material.

Effect of Alloying on the Physical Properties

When zinc is added to an aluminum alloy, the tensile strength increases gradually until 12 per cent zinc has been added, when it is about 25,000 pounds per square inch; however, the strength increases up to 35 per cent zinc. The average tensile strength of test bars taken from an aluminum-zinc alloy containing a little iron was over 50,000 pounds per square inch. This is not considered a good alloy, because it is brittle and its specific gravity is over 3.3; thus a high zinc alloy is generally unsuitable for engineering uses. The addition of copper to aluminum raises the tensile strength of the alloy until it is over 20,000 pounds per square inch when 14 per cent copper has been added. The maximum tensile strength obtained by adding iron is about 16,000 pounds per square inch when the percentage of iron is about 2.5, and the maximum tensile strength obtained by adding nickel, is slightly more than 18,000 pounds per square inch when approximately 5 per cent nickel has been added.

When the effect of these same elements on ductility is measured by the percentage of elongation, it is found that copper reduces the ductility faster than any of the other elements. The addition of iron is not desirable above 2 per cent, while nickel produces about the same result as copper. The addition of zinc also decreases the ductility of the castings, but not nearly so rapidly as the other elements. Experiments were made to determine the effects of temperature on two different alloys, one of which was a strong alloy known as Lynite No. 145 which contains about 2.75 per cent copper, 7 to 8 per cent zinc, and over 1 per cent iron. The sample tested had a tensile strength of 28,000 pounds per square inch and an elongation of 8 per cent at 32 degrees F. In testing it with a rise in temperature, it was found that its strength decreased regularly up to 572 degrees F., at which it was slightly under 9500 pounds per square inch. On the other hand, its elongation increased rapidly with an increase in temperature.

The other alloy contained about 12 per cent copper and 0.75 per cent manganese. The addition of the latter element made this alloy stronger at temperatures above room temperature; the elongation increased slightly, but its change was not marked. The tensile strength, however, increased from about 20,000 up to almost 22,000 pounds per square inch which was reached at 392 degrees F. At 572 degrees F. the first alloy had a tensile strength of 9500 pounds per square inch, while that of the second was more than 18,000 pounds per square inch. Thus, the second alloy was twice as strong as the first at this temperature with sufficient ductility, over 2 per cent, to make this advantage a decided factor in its use. This alloy is used to some extent at present in experimental cylinders, in cylinder heads, and any other parts requiring considerable strength at high temperatures.

Comparing Aluminum with Other Metals

A comparison of aluminum with machine steel is interesting, especially in connection with fatigue values. The modulus of elasticity of machine steel is 30,000,000 pounds per square inch and that of aluminum, 10,000,000 pounds per square inch. Machine steel breaks sharply after its elastic limit has been reached, and a slight increase in the load produces a large permanent set, whereas in forged aluminum, a slight permanent set is obtained and the metal has the ability to check its deformation after passing the yield point. Although cast aluminum alloys have the same modulus of elasticity as forged alloys, the proportional limit is usually low, being about 7500 pounds per square inch, as opposed to 22,000 pounds per square inch.

The fatigue values obtained in tests made on a White-Souther machine are unique. An aluminum casting stressed to 14,000 pounds per square inch, which was well above its proportional limit, broke after about 500,000 reversals. When a similar casting was stressed to 8500 pounds per square inch it required 16,000,000 reversals to break it. Mild steel having a tensile strength of 65,000 pounds per square inch, an elongation of 30 per cent, and a yield point of 30,000 pounds per square inch will break at 16,000,000 reversals when stressed to only 12,000 pounds per square inch. The point to be explained is why mild steel, either annealed or cold-worked, will break at 12,000 pounds per square inch, which is below the proportional limit, while aluminum will stand the same number of reversals when stressed a little above its proportional limit.

Aluminum Forging Alloys

The forging alloys are mixed like other aluminum alloys and poured into ingot form; the ingots are either rolled or pressed out into billets, which are then forged into various

shapes. It has been the experience that forgings give very uniform results. Heat-treatment improves the qualities; an untreated alloy having a tensile strength of about 40,000 pounds per square inch and an elongation of about 15 per cent, if properly heat-treated, will have a tensile strength of about 55,000 pounds per square inch, an elongation of 20 per cent, and an elastic limit of 20,000 pounds per square inch. Thus, a material is obtained having the properties of mild steel with one-third its specific gravity.

The stiffness or rigidity of a material is an important factor in engineering; stiffness depends directly on the modulus of elasticity of the material and varies as the cube of the thickness of any section. Here again, aluminum alloys possess advantages as structural members. An aluminum plate of the same weight as a steel plate would be about three times as thick and, having one-third the modulus of elasticity, its stiffness would be only one-third in so far as this factor enters; but being three times as thick as the steel plate, it would be twenty-seven times more rigid if it had the same modulus of elasticity. Dividing this figure by 3, a ratio of 9 to 1 in favor of aluminum is obtained. For alloys slightly heavier than aluminum, that ratio is 7½ and 8 to 1 instead of 9 to 1. Figured the other way, with one-half the weight in plate section, aluminum would be equally as stiff as steel; this factor is quite important when designing parts for rigidity.

Aluminum forgings have applications for different purposes due to different requirements. One factor is lightness; where this is desired in reciprocating parts of automobiles, aluminum connecting-rods would probably be valuable chiefly because of this factor. Forged aluminum seems to be a very good bearing material against hard steel and possibly against medium steel. Accordingly, two advantages can be gained by using aluminum connecting-rods—improved bearing qualities and a reduction in weight. Moreover, if the aluminum bears directly on steel, ideal conditions for cooling the bearing result; as aluminum has a high heat conductivity, it should rapidly dissipate the heat from the bearing.

Another important advantage aluminum alloys have in certain cases, arises from the absence of corrosion. It is true that a coating or oxide forms on the surface of aluminum, but as all the salts of aluminum are white, the oxide is inconspicuous. This is true of zinc also; zinc oxide is white and consequently when a piece of iron is galvanized and a coating of zinc oxide is formed on the outside, it is not thought of as rust. However, in its way it has been rusted, but the rust is white or colorless. Even though all aluminum products have oxide on the outside, it is colorless and also thin. Another characteristic of aluminum is its coefficient of expansion. In an ordinary timing-gear system the gears might be rigidly attached to one aluminum casting, and as aluminum expands about twice as much as iron per degree, it might be found that the iron gears have too great a clearance when the engine is warm. Aluminum gears, or even one of them, would reduce that clearance on account of the greater coefficient of expansion.

* * *

The elimination of hauling coal in a tender for each locomotive by electrifying its lines, has resulted in various economies for the Chicago, Milwaukee & St. Paul Railway. This has not only tremendously reduced the coal consumption of the railroad, but has increased the ton-mileage approximately 8 per cent on the mountain divisions. The greater power of the electric locomotives, as demonstrated daily in actual service as well as in the more spectacular tests of strength with steam locomotives in which the latter have come out second best, has practically doubled the ton-mileage of the three electrified divisions with no increase in trackage beyond that incident to the normal development of the railroad, and with a great reduction in the number of locomotives, instead of the increase which would have been necessary under steam operation.

NEW BOOK ON PATTERNMAKING

PATTERNMAKING. By Joseph A. Shelly. 341 pages, 6 by 9 inches; 259 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $3.

This treatise on patternmaking deals, in its sixteen chapters, with two general subjects which include, first, the principles governing the production of castings by forming suitable molds from patterns, and, second, the actual construction of patterns and core-boxes of different types. As patternmakers must understand the principles of molding, the application of various types of patterns and their relation to the work of the molder have been explained before considering the building of patterns. The types of patterns that illustrate different problems in the pattern shop and foundry have been carefully selected, in order to demonstrate every important variation likely to arise in practice. Since the construction of wooden patterns involves considerable skill, especially in the art of joinery, the use of hand- and power-operated woodworking tools and the particular classes of work for which they are adapted are fully described and illustrated.

In dealing with the general subject of pattern construction, the idea has been to explain very thoroughly the elements or fundamental features of this work. For instance, much attention has been paid to the exact procedure in the fitting or joining of different parts, and to the building up and formation of various shapes common to pattern construction, because it was considered more important to explain fully how parts are sawed, chiseled, planed, turned, and fastened together, than to fill the book with miscellaneous and unrelated examples of pattern work. The numerous examples included have been selected either to illustrate different well-known methods of construction, or the various types of patterns in common use and their application.

While this treatise is intended primarily for those interested in patternmaking as a vocation, it should also prove of value to draftsmen, for the reason that the origination of designs which are practicable from the viewpoint of the patternmaker and molder requires a knowledge of the fundamental principles of patternmaking. The various subjects treated have been so arranged and divided throughout the book that the student interested more in general principles than in the actual work of construction may readily select whatever sections are considered essential.

The scope of the book and the practical nature of the subjects treated are indicated by the following list of chapter headings: Types of Patterns and their Relation to Molding Problems; Hand or Bench Tools used in Patternmaking; Pattern Shop Machinery and its Operation; Pattern Joinery; Staved, Stepped, and Segment Work; The Laying out of Patterns; Typical Examples of Pattern Work; Core-box Construction; Pattern Turning; Pattern Work on Cylinders; Wheel and Propeller Patterns; Gear Patterns; Special Pattern Work; Finishing Pattern Work; Pattern Lumber; and Filing and Setting Jaws.

* * *

MEETING OF THE BROOKLYN ENGINEERS' CLUB

On Thursday evening, November 18, the second of a series of papers on "Industrial Brooklyn" was read at the Brooklyn Engineers Club by O. P. Hatton, advertising manager of the E. W. Bliss Co., Brooklyn, N. Y. Following a historical sketch of the development of the press working of metals, Mr. Hatton told of the entrance of the E. W. Bliss Co. into this field in 1857 and showed a large number of interesting lantern slides, illustrating progress made by his firm in the development of the various types of power presses, and a number of manufacturing operations on which such equipments are successfully employed at the present time. The Thursday evening meeting at the club was followed by a Saturday afternoon excursion to the E. W. Bliss Co.'s plant in South Brooklyn.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application

Kingsbury Automatic Drilling Machine

In working out the design of this machine, the force of gravity has been employed to provide for feeding the drills through the work. This gravity feed becomes effective when the drill starts cutting, and remains operative until the hole is drilled. A mechanical device provides for rapidly lowering the drill to the work and for returning it to the starting point after the operation has been completed. Another noteworthy feature of the design is the incorporation of an automatic mechanism which stops the machine if the drilling time exceeds a specified limit, due either to dullness or improper grinding of the drills.

An automatic sensitive ball bearing drilling machine equipped with a gravity feed and an automatic stop, which provides for keeping the drilling time within a specified limit, has recently been placed on the market by the Kingsbury Mfg. Co., Keene, N. H. This machine was originally developed and used in the Kingsbury plant, and the results obtained from its operation proved so successful that a decision was reached to place it on the market. Front and rear views are illustrated in Figs. 1 and 2 from which it will be seen that drilling machines of this type may be equipped for operation either with electric motor drive or with belt drive.

Where an individual motor is employed, power is transmitted to the main shaft *A* by means of a noiseless chain; and for belt drive, it will be seen that tight and loose pulleys are mounted directly on

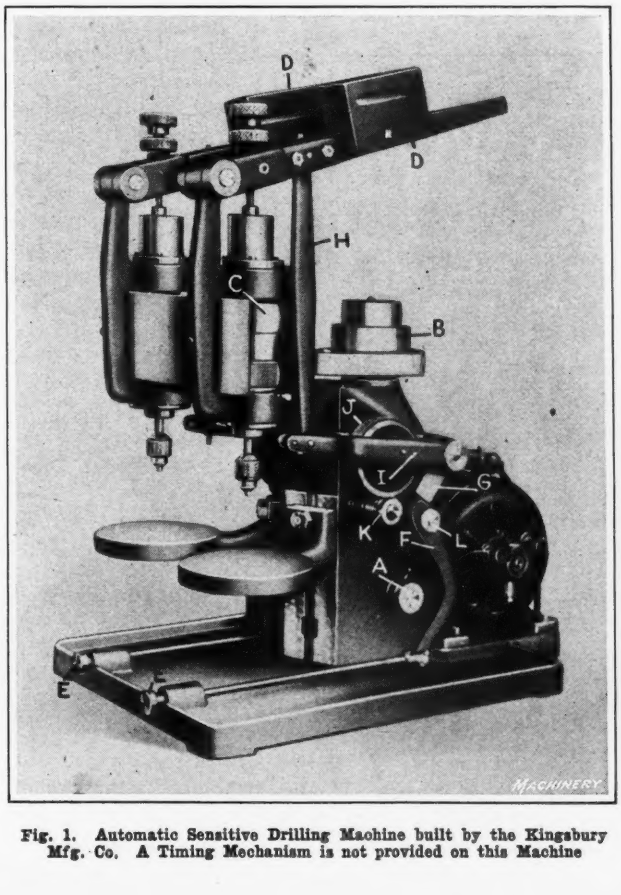


Fig. 1. Automatic Sensitive Drilling Machine built by the Kingsbury Mfg. Co. A Timing Mechanism is not provided on this Machine

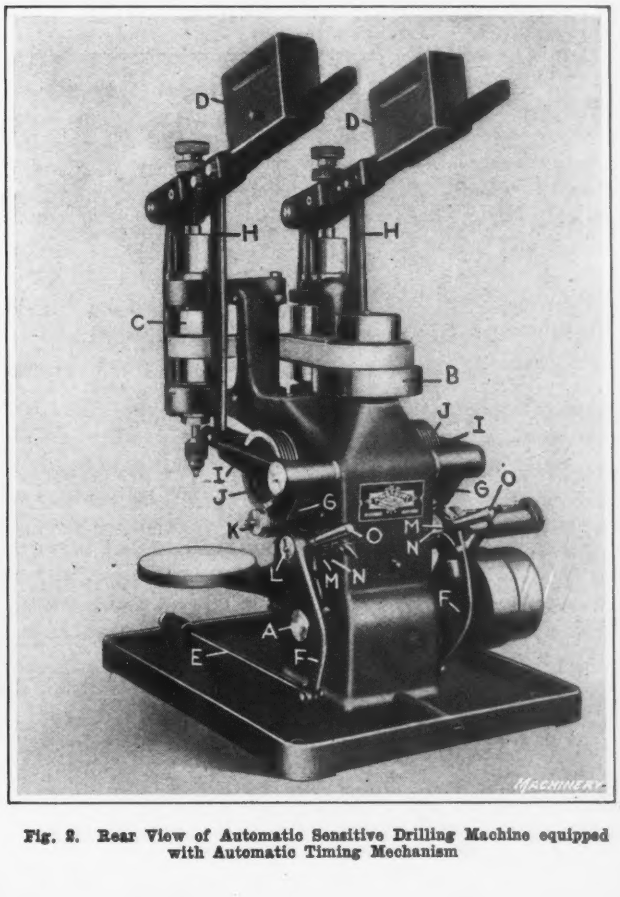


Fig. 2. Rear View of Automatic Sensitive Drilling Machine equipped with Automatic Timing Mechanism

shaft *A*; otherwise, the machines are identical in construction. Bevel gears transmit power from shaft *A* to a vertical shaft inside the column, at the upper end of which cone pulley *B* is mounted. A belt runs over this cone and idler pulleys which are so positioned that the belt has an adequate surface of contact with the cone pulley *C* on each of the spindles. One of the idler pulleys can be seen in the rear view of the machine, Fig. 2.

Arrangement of the Gravity Feed Mechanism

On these machines, each of the two spindles operates independently, and the feeding of the drill into the work is accomplished by a weight *D* which exerts a constant feeding pressure from the moment that the drill engages the work until it has completed its operation. The spindle is carried down to bring the drill to the work, and returned after the drilling operation has been completed by means of a combination of levers and a friction-driven crank disk, which operate in the following manner: When a piece of work has been placed under either of the spindles, the operator pushes rod *E* inward, which results in throwing latch *F* out of engagement with the end of arm *G* of a bellcrank lever *I*, thus allowing weight *D* to push downward on link *H* and lever *I*, with the result that a friction-driven crank disk *J*, the crankpin of which is pivoted in lever *I* comes into contact with a driving member *K*.

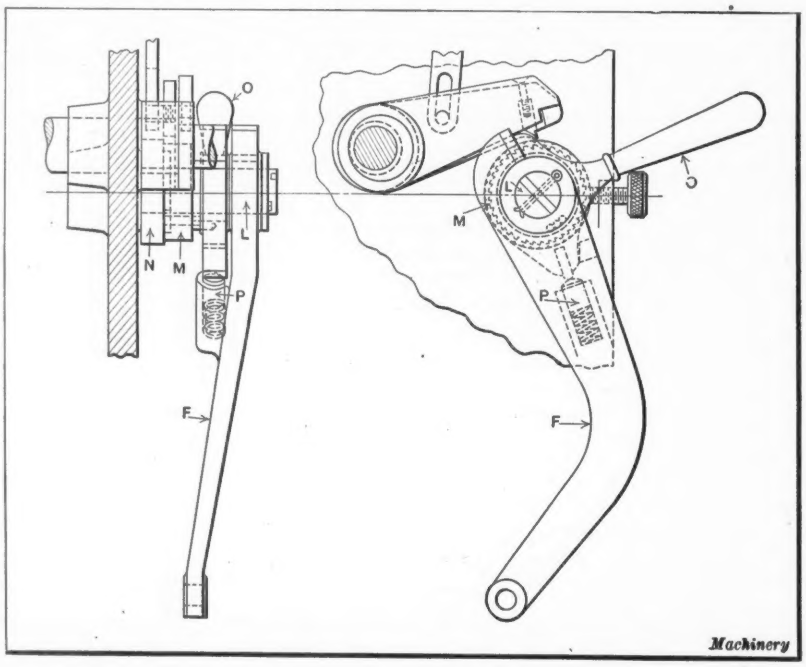


Fig. 3. Design of Timing Mechanism provided on Machine illustrated in Fig. 2

Near the middle of the vertical shaft which carries pulley *B* at its upper end, there is a worm that meshes with a worm-wheel carried at the center of the shaft on which the two grooved friction driving members *K* are mounted; and when the crank disk *J* at each side of the machine is carried down into engagement with the driving member *K*, the disk is rotated through the frictional action of the grooved contact surfaces of these two members. As previously mentioned, the crankpin in disk *J* runs in a bearing in lever *I*, so that the revolution of the disk results in pulling downward on link *H* and lever *I*, thus rapidly drawing the spindle down to bring the drill into contact with the work.

Method of Operating the Machine

With a two-spindle machine of this kind, the method of procedure is to load the jig under one spindle and start the operation by pushing inward on rod *E*, and then to start the second spindle to work. By operating the spindles alternately in this way, non-productive time of the workman is reduced to a minimum, thus effecting a substantial improvement in the rate of production. For this reason it will be apparent that it was an important matter to provide for the independent functioning of the mechanisms controlling the feed of the two spindles.

How the Gravity Feed Becomes Effective

When the point of the drill comes into contact with the work, the resistance offered to its penetration is sufficient to lift friction disk *J* out of engagement with the driving member *K*, thus disengaging the friction drive and placing dependence on the action of gravity on weight *D* to feed the drill through the work; but when the drilling operation has been completed and there is no longer any resistance to the advance of the drill, weight *D* once more establishes contact between crank disk *J* and driving member *K*, and through the link mechanism provides for rapidly raising the spindle to the starting point. The design has been worked out in such a way that when the spindle has been raised to the top of its stroke, latch *F* may snap in under the end of the bellcrank arm *G*, thus stopping the operation until rod *E* is once more pushed in.

This machine may also be arranged to operate continuously by securing latch *F* in such a position that it will not come into contact with bellcrank arm *G*. It is claimed for this machine, that owing to the uniform gravity feeding pressure, the breakage of drills will be reduced to a minimum. The arrangement of crank disk *J*, which provides for rapidly bringing the drill down into contact with the work, is such that there is a slowing up of the downward movement before contact is actually established, so that there is no danger of the impact being sufficient to break the drill. Evidently each of the weights *D* can be moved along the arm by which it is carried in order to adjust the feeding pressure according to the size of drill that is being used.

In setting up one of these machines for the performance of a specified drilling operation, the first step is to ascertain the most desirable rate of speed and feed for handling the job. With these data available, the drilling time is easily calculated and the automatic efficiency device is then set to provide for stopping the machine if the use of a dull or improperly ground drill is causing the drilling time to extend over more than the proper period. Referring to Fig. 3, the arrangement of this device is as follows: Secured to stud *L* on which link *F* is pivoted, there is a ratchet wheel *M* which is engaged by two pawls. One of these is actuated by an eccentric connected to the feed mechanism, while the other is a retaining pawl that holds the ratchet wheel in position against the tension of a spring, as it is turned by the first pawl.

If the drilling operation is completed within the specified length of time, the returning of the drill to its starting position causes lever *I*, Figs. 1 and 2, to lift both of the pawls out of engagement with ratchet *M*, so that the spring may return this ratchet to the starting position, which is determined by means of an adjustable graduated disk *N* carried on stud *L* between the ratchet wheel and the frame of the machine. As the ratchet snaps back to its starting position, a pin on the side of the ratchet comes into contact with a pin on the side of disk *N* which arrests the backward movement of the ratchet.

How the Machine is Stopped if the Time Limit is Exceeded

Should it happen that the drill has become dull, thus preventing it from accomplishing the drilling operation within a specified time limit, forward rotation of the ratchet *M* is continued, and a pin on the opposite side of this ratchet comes into contact with a corresponding pin carried by lever *O* and swings this lever over into such a position that, as

the drilling spindle rises toward its starting position, a lug on lever *O* comes into contact with the end *G* of bellcrank lever *I* and arrests the movement before the cycle of operations has been completed, thus preventing further operation of the machine and notifying the operator that satisfactory working conditions are not being secured. Lever *F* carries a spring plunger *P* that runs over a pin mounted on the hub of lever *O*, to provide for holding this lever in either of its two positions. In order to restart the machine, the operator has to pull up on handle *O*, thus causing plunger *P* to first move inward and then latch the lever in the operating position. With an arrangement of this kind, it will be apparent that a constant safeguard is placed upon the efficiency of the operation.

AUTOMATIC MULTIPLE-SPINDLE PROFILE MILLING MACHINE

A recent modification of the Coulter automatic multiple-spindle profile milling machine has been brought out by the Automatic Machine Co., Bridgeport, Conn. In Fig. 1 one of the machines is shown equipped with three spindles, while in Fig. 2 there is illustrated another machine having four spindles. Each of these machines is provided with a transfer table on which two work-holding fixtures are mounted, so that while one fixture is in the proper position for milling the work, the other is in a suitable position for unloading and loading. By this arrangement a practically continuous milling operation is obtained. In addition, a further saving in production time is secured by having several spindles cutting simultaneously.

The machine in Fig. 1 is engaged in milling the faces of manifold bosses, while in Fig. 2 the under sides of these bosses are being machined. A cam-actuated mechanism automatically feeds the work into the cutters and withdraws it when the required cut has been taken, this camming being arranged to give a rapid advance, a normal feed while cutting, and a quick return. An automatic stop is furnished, so that the minimum amount of time is consumed in non-productive motions. Each spindle has an independent adjustment for depth. The spindle housing is raised and lowered by means of the inclined handwheel directly above

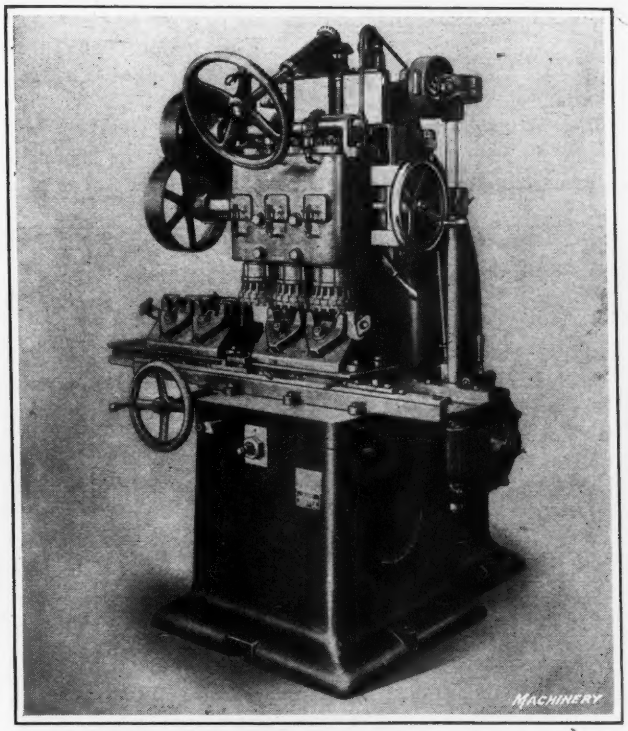


Fig. 1. Three-spindle Profile Milling Machine built by the Automatic Machine Co.

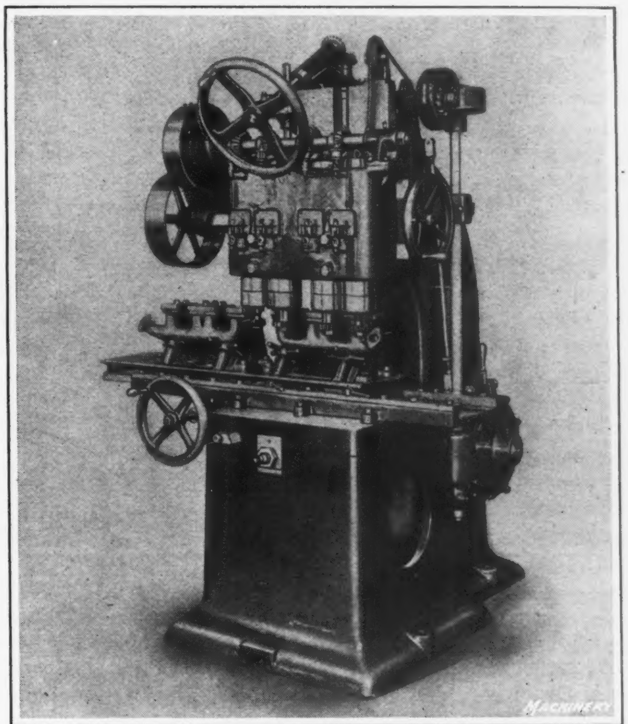


Fig. 2. Four-spindle Machine engaged in milling the Under Sides of Manifold Bosses

it, and it is moved horizontally by rotating the handwheel at the right-hand end of the cross-slide. An adjustment is provided on the transverse position of the table, the latter being moved longitudinally from the cutting position for one fixture to the cutting position for the other, by one turn of the handwheel at the left of the base.

This is essentially a single-purpose production machine, but it is adaptable to a wide range of work, as the position and number of spindles and the arrangement of the cams can be made to suit the operation. Automatic stops can be provided, to be used or not, according to the nature of the work and the skill of the operator. The spindles are driven by either bevel or spiral gears, whichever type may be deemed best for each particular case. This type of machine reduces production time and cutter wear, in comparison with single-cutter types of continuous milling machines, and the vertical spindles present an opportunity of milling surfaces that could not be machined by slab milling.

NEWTON CONTINUOUS MILLING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has recently brought out the Model 0-3 continuous milling machine shown in Fig. 1. This machine is designed for simultaneously performing face milling operations on opposite ends or faces of a large variety of machine parts, including forgings, castings, and shafts, which must be milled accurately to length. As will be seen by referring to the illustration, the machine has a heavy cast base on which are mounted the heads carrying the two cutter-spindles and the work-carrying spindles.

The head at the left end of the machine is stationary, and the one at the right is adjustable, so that work of varying lengths can be accommodated. Each cutter-spindle can be adjusted for depth of cut independently of the other. A worm and worm-wheel is employed to drive the cutter-spindles. The work-rotating spindles, or the drum-spindles on which the work-holding fixtures are mounted, are revolved by gearing. The pinions that transmit motion to the two drum-spindles are located on the same shaft, so that the two drums will always register properly with each other. The machine

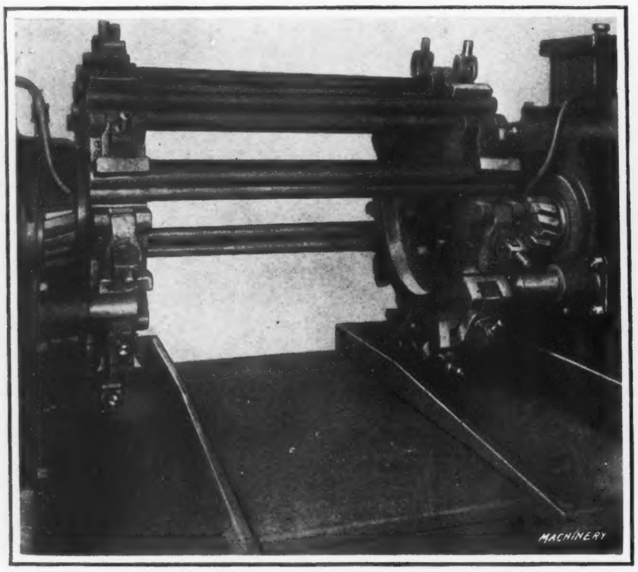


Fig. 2. Close-up View of Fixture shown in Fig. 1

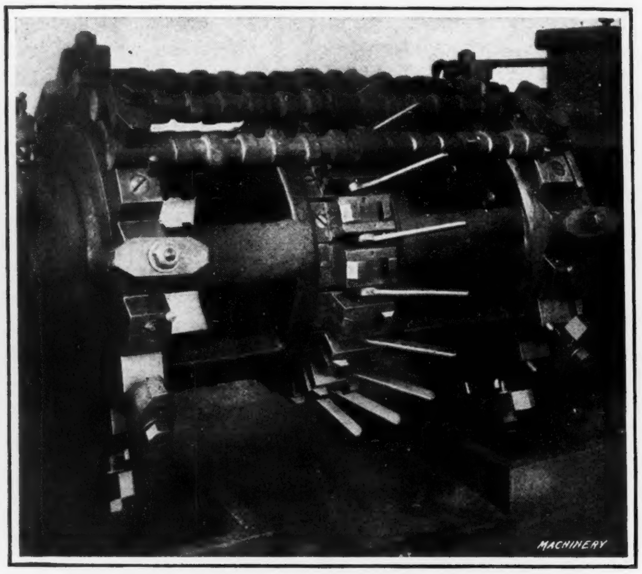


Fig. 3. Fixture used for holding Camshafts

is equipped with an oiling system which provides adequate lubrication for all bearings. The attention of a skilled workman is not required, and it is only necessary to employ an operator who has been taught the simple operation of inserting the pieces in the jig and removing them when completed.

Fig. 2 is a close-up view of the fixture shown in position on the machine in Fig. 1. This fixture is used in milling 1⅜-inch diameter shafts to length, with a production rate of 250 pieces per hour. For this operation the intermittent feed and rapid traverse mechanism is used, which permits the pockets carrying the work to be revolved past the milling cutters at the proper speed for milling, and then at an increased speed until the next pocket has been brought into position for milling the work which it carries. This change in speed is controlled automatically in the following manner: As the pocket containing the pieces revolves past the milling cutters, the feed is automatically tripped and the rapid traverse engaged, which advances the work-holding drums at a ratio of 10 to 1, and just before the next pocket reaches the milling cutters, the rapid traverse is tripped and the feed mechanism re-engaged.

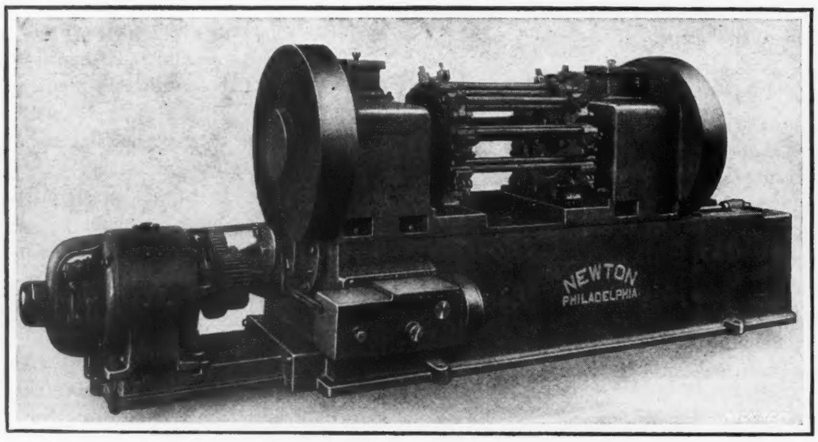


Fig. 1. Newton Model 0-3 Continuous Milling Machine

Three shafts are clamped in each pocket by the operator, who stands at the front of the machine, which is the side shown in Fig. 1. There are ten pockets in the fixture, and referring to Fig. 2; it will be observed that a toggle clamping lever is provided at the ends of each pocket, to provide for clamping the work in place. These toggle levers are so arranged that the rotation of the drum brings them into contact with pins bolted to the housings at the rear of the machine. When the levers come into contact with these pins, the clamps are released and the work rolls out on the inclined edges of the

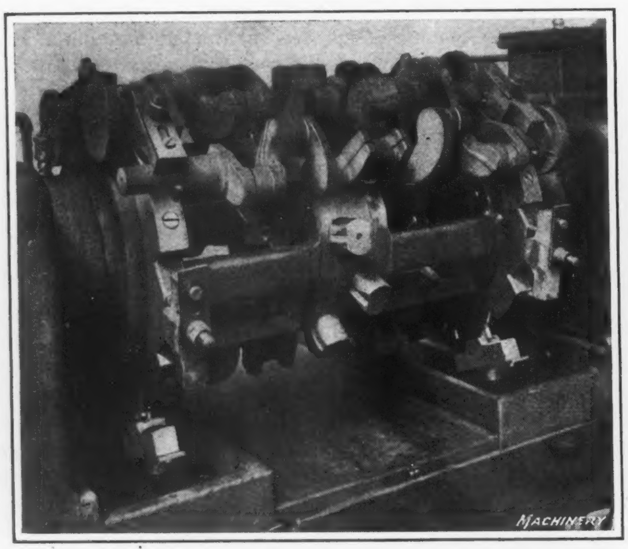


Fig. 4. Fixture used for milling Ends of Six-throw Crankshafts

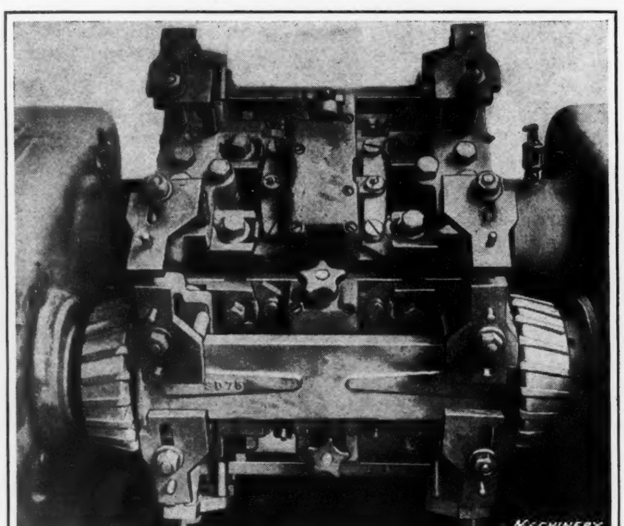


Fig. 5. Fixture used in milling Ends of Casting shown in Fig. 6

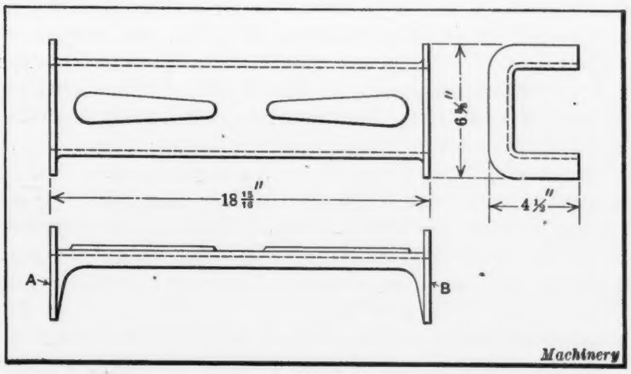


Fig. 6. Casting held in Fixture shown in Fig. 5 when milling Ends A and B

pans and from there into a tote box or on a roller conveyor. In Fig. 3 is shown a fixture designed for milling both ends of camshafts. It will be observed that a universal chuck grips the central bearing of the camshaft, and thus locates the work in the fixture. The intermittent rapid traverse feed is not used in this instance, as the work is placed close together. With this fixture the production rate is 180 milled shafts per hour.

In Fig. 4 the machine is shown set up for milling the ends of a six-throw crankshaft. In this case the work is located by plungers at the center of the fixture. By placing the crankshafts in the fixture so that the flanged end of one comes next to the small end of the succeeding one, it is possible to bring them close together. The flange on this particular crankshaft is 5 1/64 inches in diameter, the small end is ¾ inch in diameter, and the distance between the faced ends is 33 31/32 inches. The production rate on this work is 90 pieces per hour.

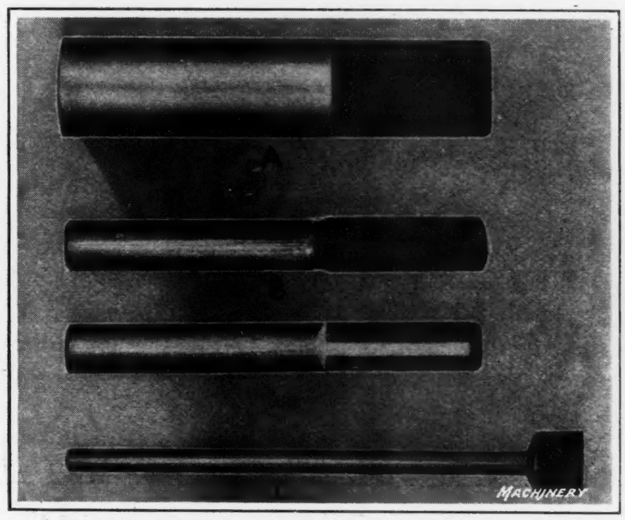


Fig. 1. Several Types of Abrasive Wheels manufactured by the Dawsearl Tool & Machine Co.

In Fig. 5 there is shown a fixture used in milling the ends of a cast-iron frame, the principal dimensions of which are given in Fig. 6. The light section of this casting necessitates the use of a fixture which is designed to prevent distortion of the work. When the frailness of the casting is taken into consideration the production of forty-five pieces per hour, which is attained when using the fixture as shown in Fig. 5, would be regarded as satisfactory by most experienced milling machine operators.

DAWSEARL FINGER ABRASIVE WHEELS

The Dawsearl Tool & Machine Co., 390 Forest St., Arlington, N. J., has recently developed a line of small abrasive "finger" wheels, which are especially adapted for resharpening button dies and for grinding small-diameter bushings, drawing dies, etc. Several types of these wheels are illustrated in Fig. 1. The wheel shown at *A* is intended for grinding large button dies, although it can be used for other work. The two wheels shown at *B* are also intended for grinding button dies, the only difference between them and the one shown at *A*, being in the diameter. One of these wheels is shown with part of the abrasive removed, thus exposing the supporting rod with which all these wheels are provided to insure against breakage. It is claimed that this reinforcement makes the wheels sufficiently rigid to insure a perfect cutting action, and yet permits enough flexibility to prevent the wheels from being broken when pressure is put upon them.

The wheel shown at *C* is especially designed for grinding bushings, drawing dies, gages, and other work of a precision nature. Wheels of this type are made to less than 1/16 inch in diameter at the cutting end, and so grinding operations can be substituted for lapping operations in many instances. Similarly, the use of these wheels in regrinding button dies, eliminates the old and slow method of performing the operation through the use of oilstones turned to the necessary size. The manufacturer of these wheels recommends their use in connection with "Dumore" grinders which are manufactured by the Wisconsin Electric Co. Fig. 2 shows one of these machines equipped with a finger wheel in use grinding a button die.

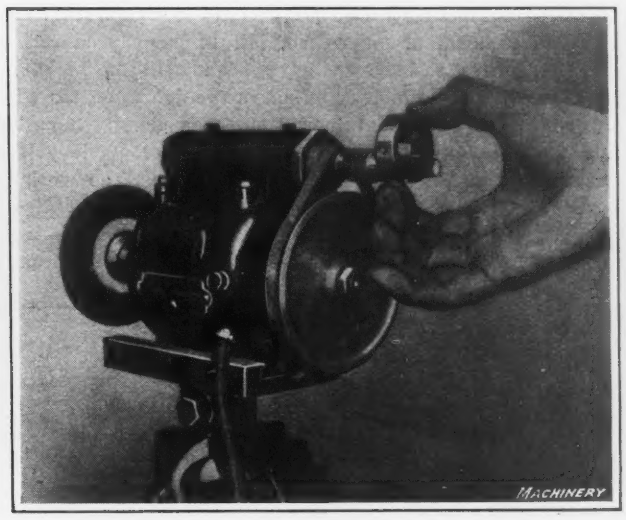
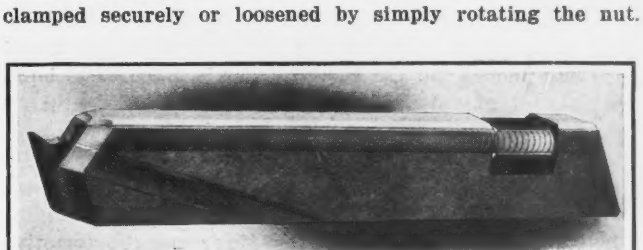


Fig. 2. "Dumore" Grinder equipped with a Dawsearl Wheel for Use in grinding a Button Die

"WILKES" TOOL-HOLDER

The Dawson Tool Corporation, 51st St. and Lancaster Ave., Philadelphia, Pa., has placed on the market the "Wilkes" tool-holder shown in the accompanying illustration. It will be seen that the tool bit is inserted in a square hole machined at an angle relative to the bottom surface of the tool-holder in order to give the proper amount of top rake. A binding screw runs the length of the tool-holder, the front end of the screw being beveled on the bottom to provide a good contact surface with the tool bit. The opposite end of this screw is threaded to suit a nut contained in a slot in the tool-holder. By this arrangement, the bit can be clamped securely or loosened by simply rotating the nut.



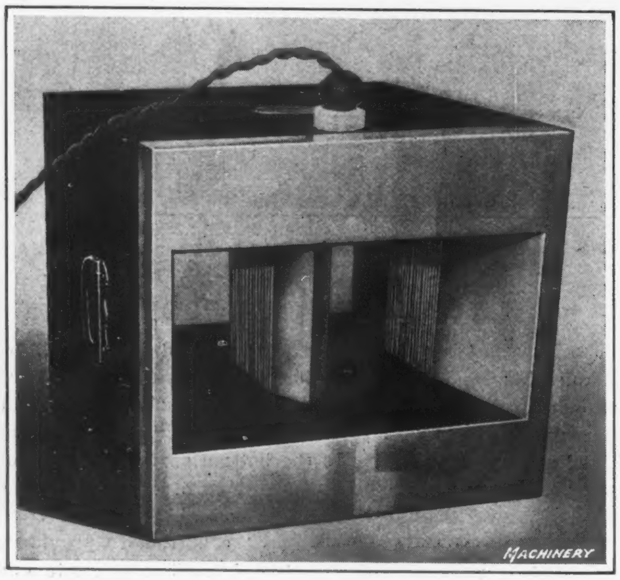
"Wilkes" Tool-holder manufactured by the Dawson Tool Corporation

The latter is a snug fit in the slot of the tool-holder, so that it cannot move in a longitudinal direction. It will be seen that the clamping action of the binding screw is close to the cutting edge of the bit.

An advantage claimed for this type of tool-holder is that its construction at the front end gives an unusual amount of support to the bit directly beneath the cutting edge. As there is no set-screw along the top surface of the holder for clamping the bit in place, as on many other types, the tool-holder can be slipped from the toolpost toward the operator, instead of toward the work. It is stated that this tool-holder is given a special heat-treatment to render it capable of withstanding severe usage. It is made in ten sizes to accommodate bits ranging from 3/16 to 1 inch square.

BREWSTER ELECTRIC DEMAGNETIZING MACHINE

The residual magnetism left in the work after holding it on magnetic chucks for a machining operation is usually undesirable, as it causes chips, etc., to adhere to the parts. In order to eliminate such a condition, it is necessary to subject such parts to a demagnetizing operation, and for this purpose the William Brewster Co., 30 Church St., New York City, has recently placed on the market a demagnetizing machine known as the "Demagnetool No. 2," which is here illustrated. This machine is especially designed to cause the rapid removal of magnetism left in parts produced in large quantities and which have been held on magnetic chucks. While the illustration shows the demagnetizer with the opening in a horizontal position, it is usually mounted on a bench in a vertical position with a receptacle placed beneath the opening. In using this machine, the work is poured through the opening, the parts becoming entirely demagnetized as they drop through and into the receptacle beneath. Where there is an occasional cutter or delicate part

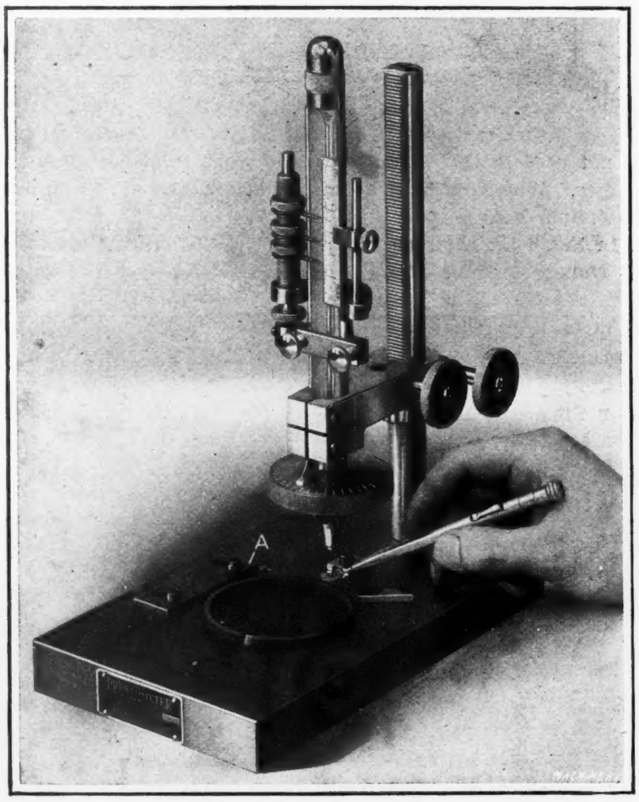


Machine built by the William Brewster Co. for removing the Residual Magnetism in Parts held on Magnetic Chucks

to be demagnetized, it can be passed through by hand instead of dropping. The opening of the machine illustrated is 10 by 6 inches, but the manufacturer is prepared to build machines of any desired size.

COATS PISTON RING GAGE

It is a matter of general knowledge among automotive engineers and users of motor cars that numerous undesirable operating conditions will result from having piston rings which do not fit properly in the grooves of the piston. For use in gaging rings to assure that their widths come within specified limits, the Coats Machine Tool Co., Inc., 110-112 W. 40th St., New York City, has worked out a special adaptation of the Prestometer fluid micrometer gage for this purpose. It will be seen from the accompanying illustration that this gage is of the standard design with the exception that hardened steel balls are used for the gaging points, and an adjustable guide is provided that enables the gage to be set for testing the accuracy of various sizes of piston rings. There are two diagonal rows of holes in the base of the gage to receive the two screws that hold the locating block *A* in place. These holes provide for securing the block in different positions for holding various sizes of piston rings between the gaging points with one point of the ring periphery in contact with the block.



Modification of Prestometer Fluid Gage to permit the Inspection of Piston Rings

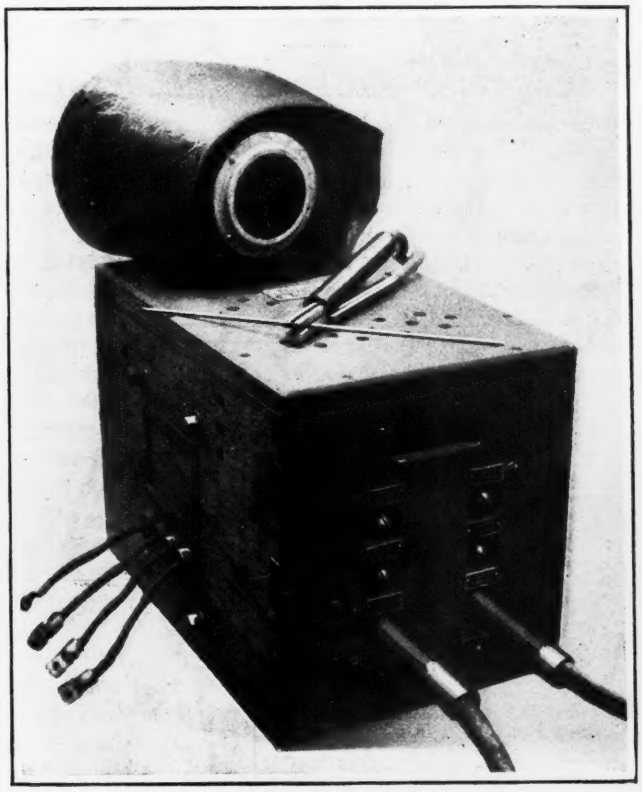
In the base of the gage there is a cup-pointed set-screw which supports a 3/8-inch hardened steel ball in such a position that the top of the ball projects slightly above the surface of the base; and carried by the plunger there is a 3/16-inch ball that engages the top of the work. This ball is held on the plunger by means of a cup that is threaded on the plunger and has an opening at the bottom through which the ball projects slightly. The use of the regular contact points on a Prestometer gage used for testing piston rings was found unsatisfactory, because the metal was so hard that the points were rapidly worn. Also, it was necessary to provide means for holding the lower contact point above the surface of the gage base, as any slight "wind" in a forged ring, or the presence of a burr, would hold the piece out of uniform contact with the base and thus give an erroneous reading. So far as the use of the Prestometer fluid gage is concerned, this application in testing piston rings is exactly the same as for other classes of service, the gage being set to standard gage-blocks and used as a comparator.

ELECTRIC ARC WELDING APPARATUS

An electric arc welding equipment weighing 100 pounds complete and especially suitable for use by automobile repair men, plumbers, sheet-metal workers, electricians, etc., has

been developed by the Electric Arc Cutting & Welding Co., Newark, N. J. This equipment uses electrodes from 1/16 to 5/32 inch in diameter, operating continuously with the medium and smaller sizes, and intermittently with the larger sizes. While it has been designed to operate on either 110 or 220 volts and at any frequency specified by the purchaser, it can also be furnished for other voltages. The power supply must be of at least five kilovolt amperes and within the underwriter's regulations. While the equipment will operate from lamp sockets with the smaller electrodes, it is not advisable to do so. However, if a current of five kilovolt amperes is available, the equipment can be operated by being connected with the panel board from which the lights are supplied.

The connections of the apparatus are very simple; two wires run from the machine to the power supply, and two wires are attached to a regulating unit on the equipment. It is stated that the uses to which this apparatus may be put cover every field of arc welding, with the possible exception of the rapid handling of very heavy work. However, it will also do heavy work, but at a reduced rate, which, while perhaps not economical for use in production, is entirely economical for emergency repairs.



Portable Electric Arc Welding Equipment built by the Electric Arc Cutting & Welding Co.

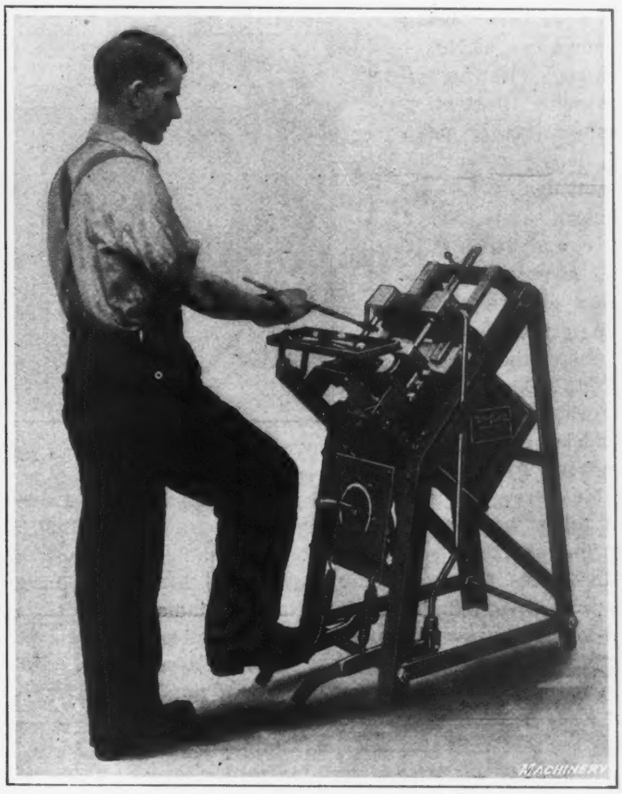
Some of the work to which the apparatus is applied in garages and automobile repair shops is as follows: Repairing scored cylinders, mud guards, mud guard brackets, cracked cylinder water jackets, frames, lamp brackets, bumper brackets, step braces, etc. Lead burning can also be done very successfully, and spot-, butt-, or tack-welding of small thin pieces can also be rapidly accomplished.

TAYLOR ELECTRIC RIVET HEATER

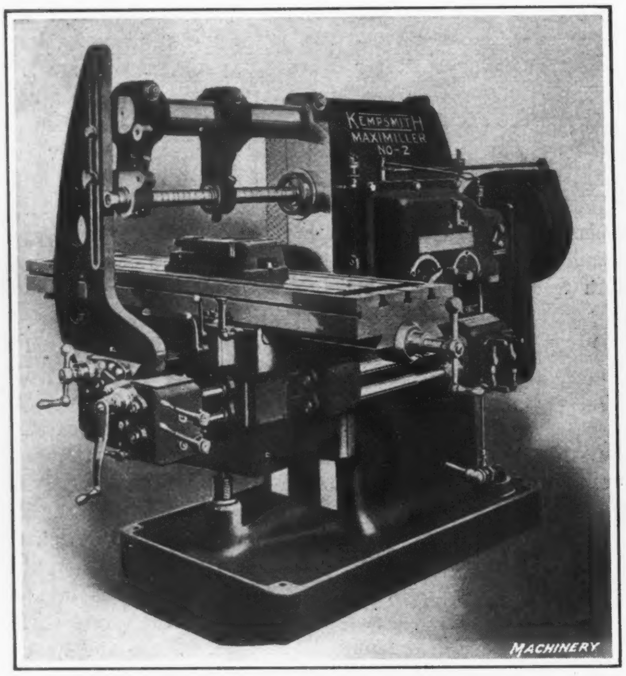
A new type of electric rivet heating machine has been developed by the Taylor Welder Co., Warren, Ohio, as shown in the accompanying illustration. This outfit can be permanently installed on a floor or a platform, or provided with a bail so that it can be picked up by a crane and moved from place to place as required. A simple plug connection is used to transmit electricity to the machine, and plugs can be located at various points about the shop. The machine illustrated is designed to heat two rivets simultaneously, but a machine can be built for heating any number of rivets in multiples of two. In most instances, however, a machine of the type shown will heat rivets sufficiently fast to keep one boy busy removing hot rivets and inserting cold ones. The time required for heating a rivet ¾ inch in diameter and 4 inches long is about thirty seconds. Of course, smaller rivets become hot in a correspondingly shorter period. Experiments have shown that 100 pounds of rivets can be heated with a current consumption of approximately 18 kilowatt hours.

In operating this machine, the top electrode is elevated by depressing one of the foot-treadles which are connected to the electrode by means of connecting-rods. The rivets are then inserted and the pressure on the treadle is released so that the electrode is lowered on the rivet heads and holds them in an upright position. The current immediately begins to flow from the terminals of the transformer through the rivet itself to the upper conductor, and then through the other rivet into the other terminal of the transformer, thus completing the circuit. In heating rivets in this manner, the heat is generated through the center of the rivet, whence it radiates toward the outside surface. Since the heat is under the absolute control of the operator, there is little tendency for the rivets to become burned, as the heat can be shut off when the best upsetting conditions have been attained.

Electrically heated rivets are not scaly when they are removed from the machine, as is commonly the case when rivets are heated in forges of the ordinary type. Therefore, they are more easily inserted in the riveting machine and also more readily headed, as their temperatures are more uniform. Some of the other advantages of this rivet heating machine are that the work is always in plain view of the operator; there are no fumes or gases delivered from the heater; there is no disagreeable heat in hot weather; there is no necessity for carrying coal or coke to the machine nor removing ashes; there is no expense when rivets are not being heated; and the machine is ready for operation at a moment's notice.



Machine built by the Taylor Welder Co. for heating Rivets electrically



Milling Machine recently introduced by the Kempsmith Mfg. Co.

KEMPSMITH NO. 2 "MAXIMILLER"

In the November, 1918, number of MACHINERY, reference was made to the first of a line of "maximillers" to be placed on the market by the Kempsmith Mfg. Co., Milwaukee, Wis., this machine being known as a No. 4 size. The accompanying illustration shows another maximiller of recent development, which is known as a No. 2 size, and which is of the same general design as the No. 4. The principal dimensions of the new machine are as follows: Working surface of table, 56 by 12 inches; T-slots in table, three, ⅝ inch in width; longitudinal power traverse of table, 28 inches; transverse power traverse of table, 10 inches; vertical power movement of table, 19 inches; distance from face of column to over-arm brace, 24¾ inches; taper hole in spindle, B. & S. No. 12; diameter of hole through spindle, 1⅛ inches; number of spindle speeds, 18; range of spindle speeds, from 16 to 400 revolutions per minute; number of feeds, 18; range of feeds, from ⅝ to 25 inches per minute; rate of quick longitudinal traverse of table, 100 inches per minute; rate of quick transverse or vertical movements of table, 36 inches per minute; and floor space required, 85 inches in direction of spindle, and 105 inches in direction of longitudinal movement of table. The net weight of the machine is 4200 pounds.

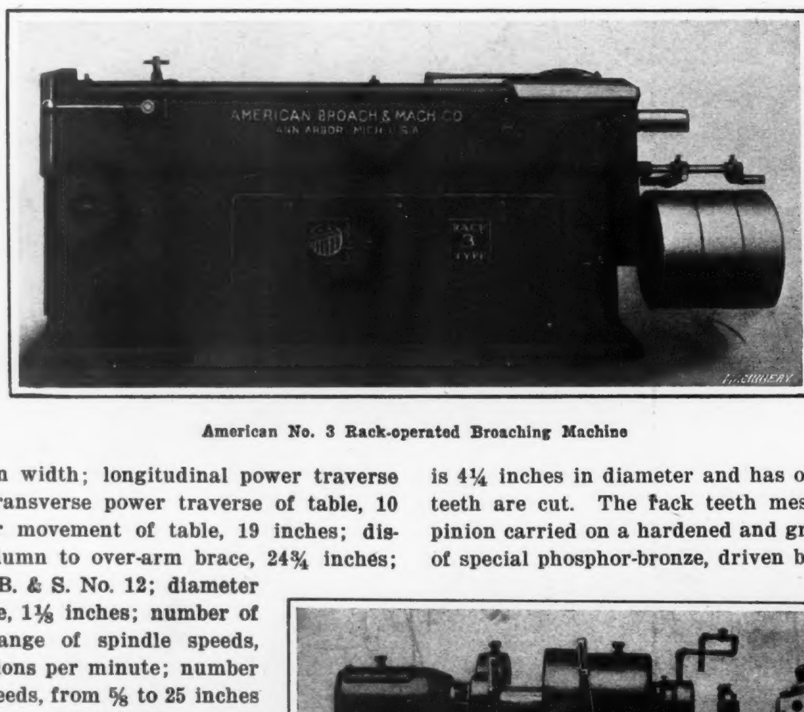
MOTOR BASE ON WOOD TURRET LATHES

A new design of motor base and single belt drive which has recently been brought out by the Wood Turret Machine Co., Brazil, Ind., is shown in the accompanying illustration applied to one of the machines of this company's manufacture. This motor base, or cabinet leg, is so arranged that the motor can be easily removed for cleaning, or when repairs are necessary, by unloosening three machine screws which hold the circular cover to the left end of the base. Power is transmitted from the motor to the driving pulley on the spindle of the machine by means of a belt which passes through the pan and around the pulley, the tension of this belt being controlled by a double-acting idler which is operated by the hand-lever shown at the right-hand end of the base. The belt is fully guarded by means of a cast-iron cover.

This type of motor drive arrangement is being supplied on the Nos. 2, 3, and 4 friction back-geared machines, direct-current variable-speed motors being used. The controller-box crank and all other operating levers on these machines are so grouped that they are within easy reach of the operator, without requiring him to change his position in front of the machine.

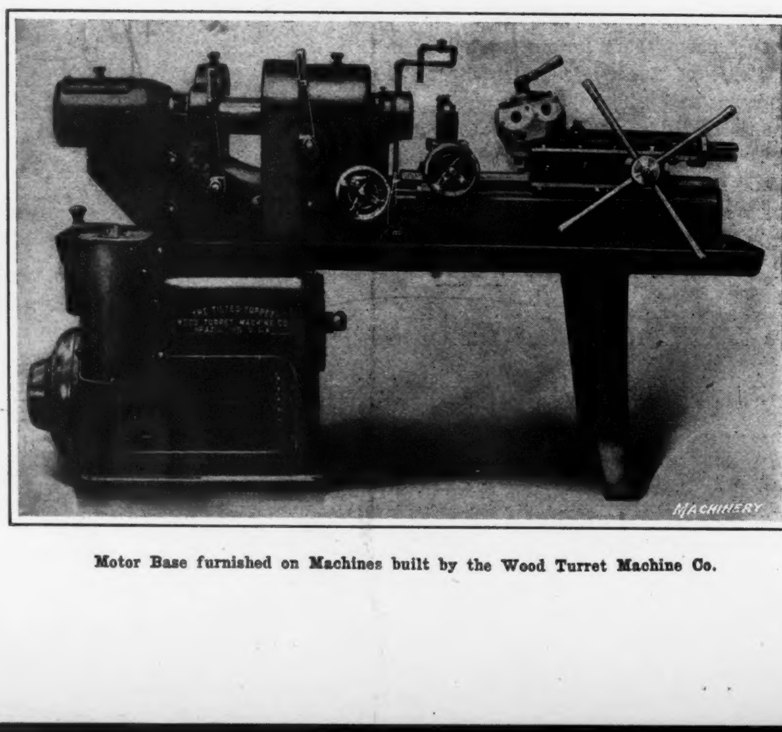
AMERICAN BROACHING MACHINE

The American Broach & Machine Co., Ann Arbor, Mich., has recently placed on the market a No. 3 broaching machine which is of the rack-operated type. This machine has a capacity for broaching round or square holes up to 3½ inches, using broaches up to 58 inches in length. The face of the machine is finished within 6 inches of the floor and is provided with two T-slots for use in holding special fixtures. As will be seen by referring to the accompanying illustration, the base is of the cabinet type. Shelves for holding broaches and a compartment which serves as an oil reservoir are located in the base. The starting head of the machine is made from a solid steel billet, fitted with hardened and ground steel shoes which slide in box-shaped ways.



American No. 3 Rack-operated Broaching Machine

The sliding head is fitted with a central broach-block that permits bringing the vertical head into accurate alignment for central broaching. The rack is 4¼ inches in diameter and has one flat side on which the teeth are cut. The rack teeth mesh with a hardened steel pinion carried on a hardened and ground shaft. A worm-gear of special phosphor-bronze, driven by a hardened steel worm,



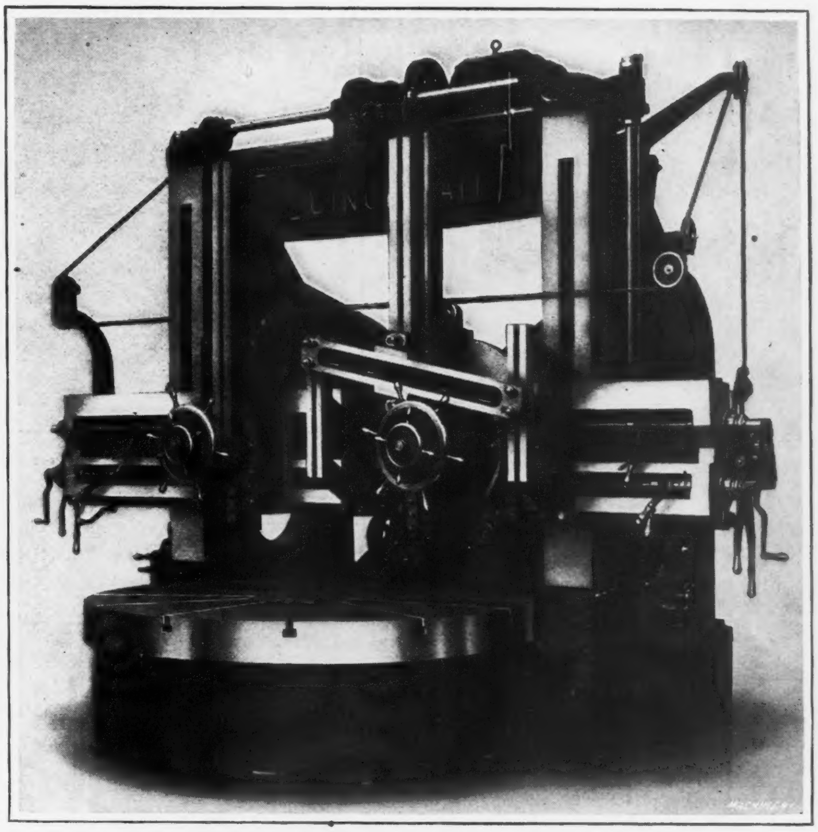
Motor Base furnished on Machines built by the Wood Turret Machine Co.

is keyed to the pinion-shaft. The worm is provided with two roller thrust bearings to receive the end thrusts.

The machine is fitted with an automatic brake which absorbs the momentum of the moving parts when the operating head has reached the end of the stroke. Automatic stops which can be adjusted to give different lengths of stroke are provided. The reverse stroke has twice the speed of the cutting stroke. The loose pulleys are mounted on Hyatt roller bearings, and an oil pump and oil trough are furnished as part of the regular equipment.

TAPER ATTACHMENT FOR CINCINNATI BORING MILLS

For use in turning and boring tapers which approach the horizontal so closely that swiveling of the head is not practicable, the Cincinnati Planer Co., Cincinnati, Ohio, has developed a taper turning and boring attachment for use on all sizes of boring mills of its manufacture from 42 inches up to 12 feet. The accompanying illustration shows the attachment on an 8-foot mill, and component parts such as the sine bar supports, sine bar, and sine bar guide are all clearly shown. To provide up and down adjustment of the ram, without loosening the sine bar and thereby changing its position, the faces of the ram are especially machined and fitted with a T-slot equal in length to the up and down travel. In mounting, the sine bar supports, sine bar guide, and sine bar are placed loosely in position and clamped securely in place after the proper angle has been determined. Power feed to the ram is then disengaged by means of the small handwheel, after which the attachment is ready for operation. Its use is recommended for angles up to and including 18 degrees.



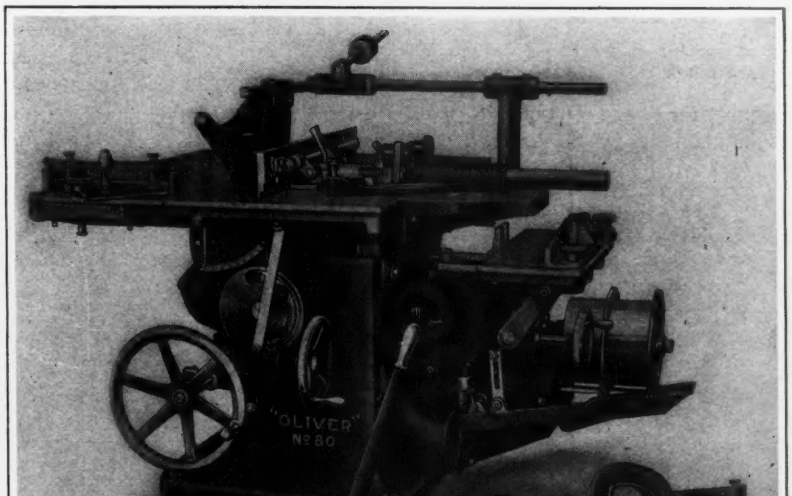
Taper Attachment for Use on Boring Mills built by the Cincinnati Planer Co.

OLIVER NO. 80 SAW BENCH

A variety saw bench known as the No. 80 has been added to the line of equipment built by the Oliver Machinery Co., Grand Rapids, Mich. This machine, which is shown in the accompanying illustration, was designed to meet modern demands in the production of wooden patterns, furniture, automobile bodies, agricultural implements, talking machine cabinets, etc. It will rip work to a width of 23 inches, and cut off to a length of 32 inches, when a universal ripping table is provided; and will rip to a width of 27 inches, and cut off to a length of 15 inches with a plain table. Stock up to 3 inches thick can be cut with a 14-inch diameter saw, or to 4 inches thick with a 16-inch diameter saw. By using a mortising and boring attachment, holes up to 2 inches in diameter and 6 inches deep can be bored, and holes up to 3/4 inch square and 4 inches deep can be mortised.

The table has a surface 36 inches wide and 44 inches long; it can be tilted to an angle of 45 degrees, and has a vertical adjustment of 4 inches. The universal table has a sliding section 15 inches wide to the left of the saw, which rolls on ball bearing ways provided with a vertical adjustment for alignment and wear. This rolling table may be moved 4 inches from the saw to permit the use of dado saws and special heads. The rolling table permits accurate cross-cutting, mitering, and grooving operations to be done. A universal ripping fence, which can be tilted to an angle of 45 degrees, may be used on either side of the saw, or secured at any angle not in line with the saw, on either the stationary or sliding table. It has a quick adjustment of 12 inches, and a micrometer device is supplied for permitting accurate adjustments to be made. A metal block is provided for attachment to the fence to serve as a stop and give clearance when cross-cutting.

A miter cut-off gage, having a capacity for cutting at angles ranging from 30 to 135 degrees, is furnished for use on the sliding table when cutting off very wide stock. The machine may be driven by either a belt or motor drive, two types of motor drives being applicable. Where two- or three-phase, sixty-cycle, alternating current is obtainable, a compact driving arrangement can be provided by mounting the motor directly on the saw arbor in place of the ordinary pulley. The more



Belt-driven Saw Bench with Mortising and Boring Attachment, built by the Oliver Machinery Co.

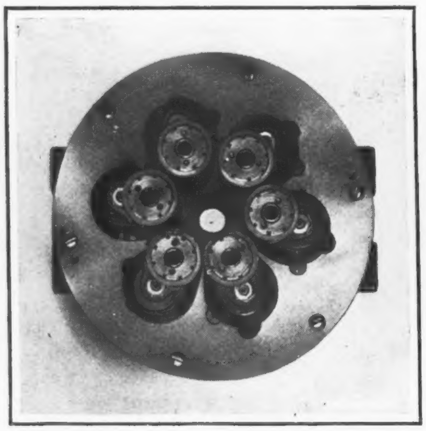


Fig. 2. Spindles set at the Minimum Distance from the Center

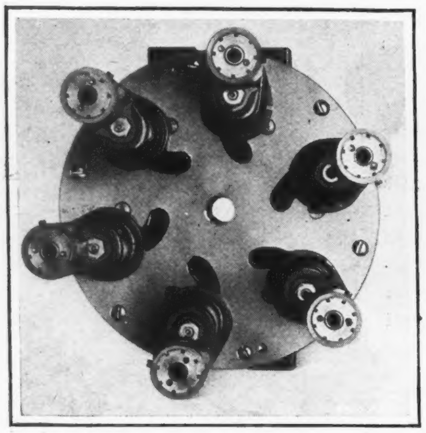


Fig. 3. Maximum Setting of Spindles from Center of Attachment

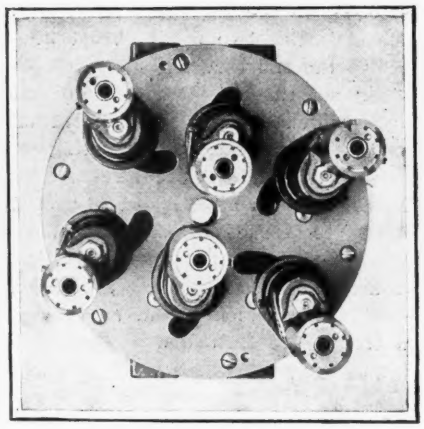


Fig. 4. Spindles set for drilling Another Combination of Holes

usual type of motor drive consists of a five-horsepower motor running at about 1800 revolutions per minute, mounted on a sub-base, with adjustment for taking up belt stretch.

"BUHR" MULTIPLE-SPINDLE DRILL HEAD

Multiple-spindle drill heads of the type shown in Fig. 1 are manufactured by the Nelson Blanck Mfg. Co., Dubois and Clay Sts., Detroit, Mich., for the purpose of adapting single-spindle drilling machines for the drilling of a number of holes at one time. A detachable adapter and driver are provided for transmitting power to a square shaft of the attachment, which is mounted on a thrust bearing having a load capacity equal to the combined thrust of all the spindles. Radial ball bearings and spur gears are used throughout the entire construction, the head is self-contained and dustproof, and all moving parts are made from heat-treated chrome-nickel steel and run in grease. Special arms can be furnished for drilling to close center distances, each spindle unit having been designed to withstand three times the stress produced by using the maximum size of drill, so that each spindle will drive several drills placed on such special arms.

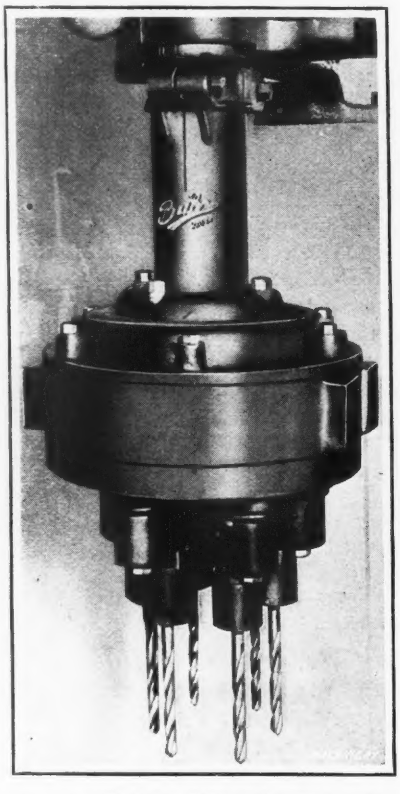


Fig. 1. Multiple-spindle Drill Head made by Nelson Blanck Mfg. Co.

The spindles of this multiple drill head can be set in various positions within certain limits to suit the holes to be drilled in the work. In Fig. 2 the spindles are arranged for drilling holes spaced about a circle of the minimum diameter that can be accommodated, while in Fig. 3, the spindles are set at their maximum distance from the center of the head. Fig. 4 shows how the different spindles can be placed, regardless of the position of the others.

These tools are known as "Buhr" multiple-spindle drill heads, and they are made in many standard sizes, the smallest head having three spindles which will drill to a minimum sized circle of 1½ inches in diameter, and to a maximum circle of 6¼ inches in diameter, the maximum size of drill that can be used being ¼ inch in diameter. The largest drill head has four spindles which can be spaced for drilling to a minimum sized circle of 4½ inches in diameter and to a maximum sized circle of 18 inches in diameter. A number of standard heads are provided with 8, 10, and 12 spindles.

SHEFFIELD SNAP GAGES

The Sheffield Machine & Tool Co., Dayton, Ohio, has recently developed a new method of constructing snap gages, which enables various styles to be quickly made up from standard parts. These parts consist of head- and foot-blocks, shown in Fig. 1, which are manufactured in quantities and provided with either adjustable or solid renewable anvils as required. In addition to these parts, castings for C-shaped cylindrical snap gages, of the type illustrated in Fig. 2, are made in sizes from ¼ inch upward. In making up a gage of this type, it is only necessary to assemble the foot- and head-blocks on a casting of the required size. Internal and

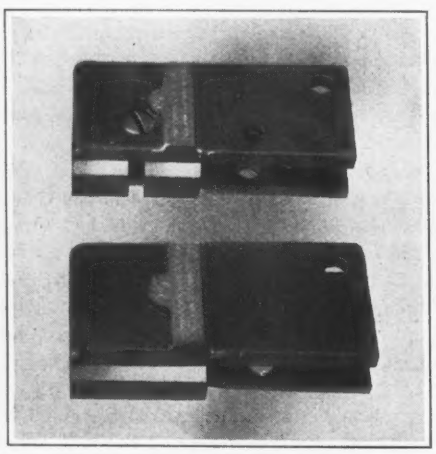


Fig. 1. Sheffield Gage Heads with Renewable Solid and Adjustable Anvils

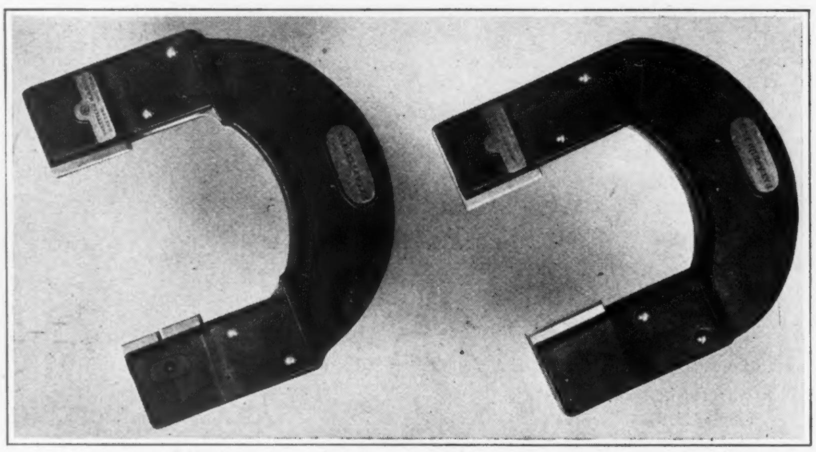


Fig. 2. Snap Gages for measuring Cylindrical Work, which are equipped with Sheffield Heads having Adjustable and Solid Renewable Anvils

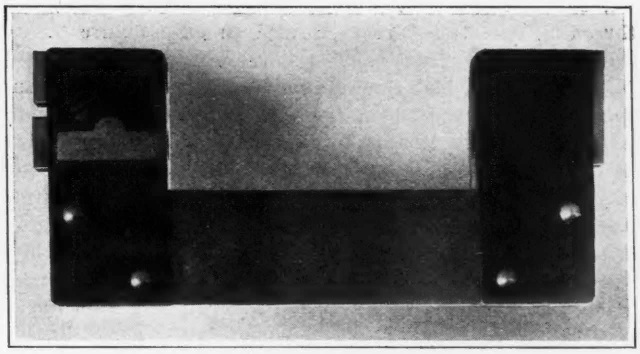


Fig. 3. Internal "Go" and "Not Go" Gage, equipped with Sheffield Heads having Renewable Solid and Adjustable Anvils

external gages such as shown in Figs. 3 and 4 are made by simply cutting a beam of strip steel to the proper length and then attaching the foot- and head-blocks as shown. Referring to Fig. 1, it will be seen that the "Go" and "Not Go" gaging points or anvils are so assembled that they form a snap gage of the two-step type for gaging the distance between two surfaces. The gage in Fig. 5 is so assembled that the solid anvils of the "Go" gage are on one side of the beam, and the solid anvils of the "Not Go" gage on the other.

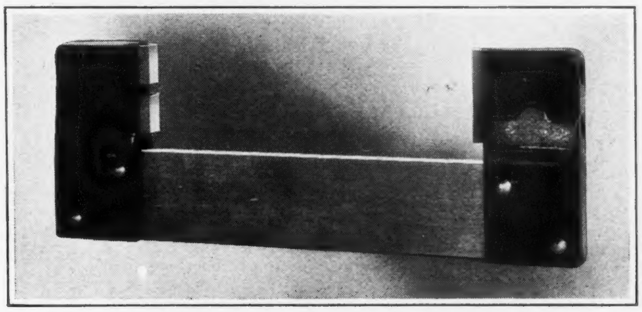


Fig. 4. External "Go" and "Not Go" Gage, equipped with Sheffield Heads having Renewable Solid and Adjustable Anvils

By the use of these Sheffield heads it is possible to quickly make any style of gage for measuring lengths, widths and thicknesses, either externally or internally, and also cylindrical work in lathes and grinders. The anvils are easily and cheaply replaced when worn, which makes the gage practically indestructible; and if the gage becomes obsolete, it is only necessary to remove the pins which hold the head- and tail-blocks to the beam or casting, and they can be used in making some other size of gage, the only scrap being the piece of strip steel which serves as a beam.

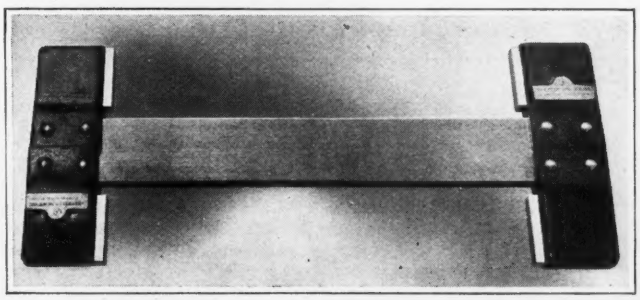
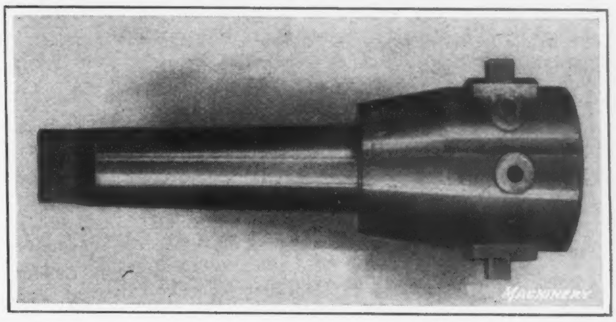


Fig. 5. Two-sided External "Go" and "Not Go" Gage equipped with Sheffield Heads having Solid Renewable Anvils

H. A. HOPKINS EXPANDING BORING-BAR

A type of expanding boring-bar which has proved satisfactory during a number of years of rough and heavy usage in railroad shops, being employed mainly in such operations as boring car wheels and journal boxes, has recently been placed on the market by H. A. Hopkins & Co., Inc., South Bend, Ind. This tool is known as the VV expanding boring-bar, being so called from its construction. The square type of cutters used gives ample strength for taking heavy cuts and an opportunity to grind a good clearance angle and rake on the cutters to facilitate the removal of metal. The cutters are adjusted radially for cutting to a specified diameter by means of a conical-pointed screw on one side of the bar, and they are locked securely in place by means of another screw having a suitable V-groove, on the opposite side.

On one job on which this type of boring-bar was employed, the operation consisted of boring automobile connecting-rods to the finished size in one cut. From 3/16 to 1/4 inch of stock was removed on a side, and 371 rods were bored before the cutters required resharpening or readjustment.



Hopkins Expanding Boring-bar

This boring-bar can be supplied in any diameter or length required for holes from 1 to 12 inches in diameter, and it can be made with single or multiple sets of cutters. On the larger bars, regular commercial tool bits can be used, this feature being considered a valuable one, as broken or worn cutters can easily be replaced from any supply house. The bars have sufficient expansion to insure long cutter life.

JACKSON VERTICAL AUTOMATIC CHUCKING MACHINE

A vertical automatic chucking machine known as the Jackson is being manufactured by the Long-Henkel Mfg. Co., 3rd and Buttonwood Sts., Reading, Pa., for the rapid quan-

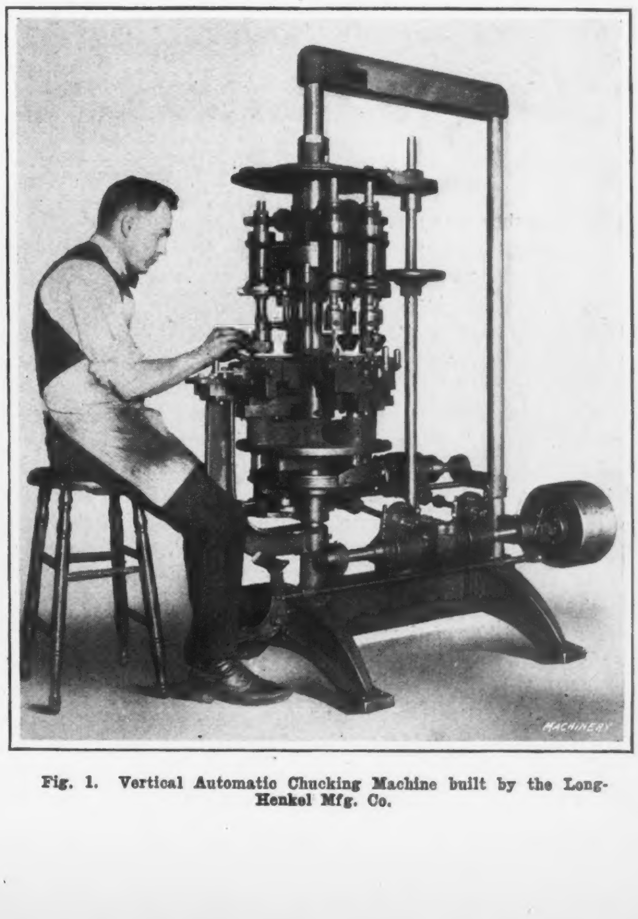


Fig. 1. Vertical Automatic Chucking Machine built by the Long-Henkel Mfg. Co.

tity production of small parts such as standard nuts, electrical fixtures, battery terminals, sash pulleys, etc. This machine is built in three different types. Fig. 1 shows a machine of the reciprocating type equipped with four duplex automatic chucking vises and three pairs of working spindles. It is mainly adapted to classes of work requiring turning, drilling, boring, tapping, or threading.

The chucking vises automatically eject the finished parts and clamp unfinished ones after they are inserted in the vises. This relieves the operator of everything but the mere handling and observation of the work. The machine has a positive drive throughout, and is fully equipped with ball bearings. Handy and quick-acting tool adjustments are provided to render the machine easy to set up. All work is constantly in full view of the operator, thus providing a safeguard against mischucking.

It is obvious that this machine permits multiple operations to be performed on the same piece of work as, for instance, drilling different sizes of holes, threading with different sizes of taps, and performing various other operations limited only ing 8000 pieces per day. Turning, pointing, drilling, and threading operations are performed on gage fixture *G*, and the output is 5000 pieces. The spiral wing-nut *H* is drilled, faced, and tapped at the rate of 5000 per day. A tapping operation is performed on the iron wing-nut *I*, 20,000 nuts being the output. Battery terminal *J* is drilled at a production rate of 20,000 pieces per day. Two holes are drilled in the cast-iron part *K* and one hole is tapped, the output being 5000 parts. The part shown at *L* is a sash pulley housing, of which 30,000 are drilled during the specified time, the same rate of production being obtained on the sash pulley *M*. The middle hole of the cast-iron part shown at *N* is drilled at the rate of 15,000 holes per day. The production secured on the pump part shown at *O* is 4000 pieces, drilling, facing, and tapping operations being performed. Door handle *P* is turned, drilled, threaded, and tapped at the rate of 5000 pieces per day. In the operations performed on pump handle *Q*, two tap holes are drilled, two holes are counterbored, and two holes are tapped, the number of parts produced per day being 5000.

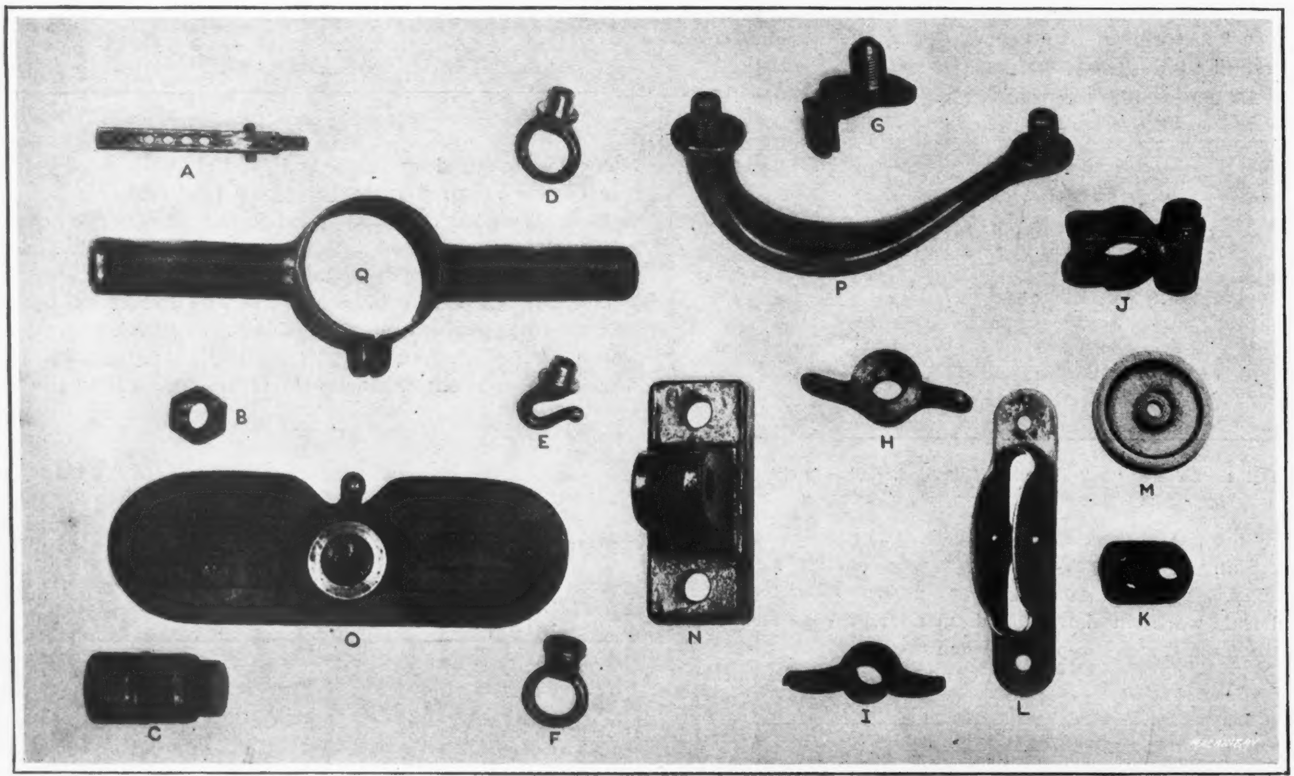


Fig. 2. Various Parts produced on the Machine illustrated in Fig. 1

by the number of spindles provided on the machine. When the machine is employed for threading or tapping standard bolts or nuts, a magazine feed appliance may be employed.

Fig. 2 shows a large variety of work which has been economically produced on machines of the type described. The operation performed on each part and the number of pieces finished per ten-hour day is given in the following, in order that an idea may be obtained of the rates of production secured: Piece *A* is a lock-bar in which four holes are drilled and tapped in two operations, the output being 10,000 pieces drilled or tapped per day. Standard nuts of the type shown at *B* are tapped at the rate of 20,000 per day. Two operations are performed on pump nipple *C*, the first of these consisting of turning, threading, and drilling, while the second consists of turning, facing, and threading the part. The number of either of these operations which can be performed per day is 5000. Electrical fixtures of the type shown at *D* are drilled, turned, faced, and threaded at the rate of 8000 per day. Identical operations are performed on the part shown at *E* and the rate of production is the same.

In the electrical fixture shown at *F*, two holes of different diameters are drilled, faced, and tapped, the production be-

NEW MACHINERY AND TOOLS NOTES

Plate Bending Brake: Dreis & Krump Mfg. Co., 2909 S. Halstead St., Chicago, Ill. A plate bending brake which weighs 30 tons and is capable of bending steel plates 12 feet long by 3/4 inch thick with the metal cold.

Pouring Device: E. J. Woodison Co., 1621 St. Aubin Ave., Detroit, Mich. A mechanical pouring device provided with adjustable levers and a counterweight which enables ladles with capacities of over 400 pounds to be lifted 18 inches.

Revolving Knife Wood Trimmer: A. E. Bauer & Son, 7021 S. Racine Ave., Chicago, Ill. A revolving knife wood trimmer having a maximum length of cut of 7 1/2 inches and a maximum height of cut of 2 1/2 inches. Guides are provided which can be set at any angle up to 45 degrees.

Headstock: S. A. Potter Tool & Machine Works, 79 E. 130th St., New York City. A headstock which is essentially the same as that used on the bench lathes of this company's manufacture, but which is especially designed for mounting on a bench for use in filing, polishing, and lapping.

Multiple-spindle Drill Heads: Roberts Mfg. Co., 152 Brewery St., New Haven, Conn. A line of multiple-spindle drill heads of the fixed-center type which may be furnished with either cast-iron or aluminum cases. These heads can be furnished with any number of spindles to hold drills up to 1 inch in diameter.

Bench Shear: Bartlett Mfg. Co., 40 E. Lafayette Ave., Detroit, Mich. A bench shear known as the No. 25, which is of the same style as the No. 20 shear of this company's manufacture, except that the cut of the new shear is 4½ inches, whereas the No. 20 has a cut of only 3 inches. This machine will cut steel bars or sheet iron up to ⅛ inch.

Riveter for Boiler Flanges: Baird Pneumatic Tool Co., Kansas City, Mo. A pneumatic riveter for marine boiler flanges, which is intended for driving rivets between the flanges of either two- or three-furnace Scotch marine boilers and similar work. The riveter is hung in a circular frame and is so balanced that it can be readily placed in any position.

Electric Welding Machine: Electric Welding Machine Co., 500 E. Larned St., Detroit, Mich. The "Weldrite" electric welding machine designed for the electric welding of cast iron and repair work in machine shops and foundries. The machines operate on 110, 220, or 440-volt alternating current where access can be had to an electric circuit delivering 75 amperes.

Scale Remover: George Oldham Son & Co., Baltimore, Md. A pneumatic tool for removing scale from boiler tubes and crown sheets, as well as paint and rust from all metal surfaces. The light, rapid strokes delivered by this device will remove scale without injury to the surface. The device measures only 3½ inches over all and weighs approximately 2½ pounds.

Pouring Ladle Heater: Wayne Oil Tank & Pump Co., Fort Wayne, Ind. A ladle heater, consisting of a frame upon which the ladle may be supported at various heights, and an inverted burner mounted on the top plate of the frame, which has a cone-shaped hood designed to blow the flame into the ladle. The burner uses oil at 5 pounds or more pressure and air at 1½ pounds.

Threading Tool: Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. A spring threading tool provided with means for quickly obtaining rigidity, so that the tool can be used for roughing or ordinary turning. The cutting tool can be swung to either side of its central position. This holder is made in sizes ranging from ⅜ by ⅞ by 5½ inches up to ¾ by 1⅝ by 8½ inches.

Coil-winding Machine: Charles Eisler, 159 Clifton Ave., Newark, N. J. A coil-winding machine intended for winding the filament coils for gas-filled, incandescent lamps, which is claimed to be capable of winding coils from 25 to 900 turns per inch for lamps of 15 to 1000 watts. The mandrels used are from 0.003 to 0.035 inch in diameter, and can be dissolved in acid after the coil is completed.

Band Saw: West Side Iron Works, Grand Rapids, Mich. A 14-inch bench band saw known as the "West Side Junior," which is intended for use in pattern shops, furniture factories, manual training schools, etc. The machine is furnished with either belt or motor drive, and has a table measuring 16½ by 19 inches. Provision is made for tilting the table to any angle up to 45 degrees.

Multiple-spindle Drill Heads: United States Drill Head Co., Cincinnati, Ohio. A line of fixed-center, multiple-spindle drill heads, each head being especially designed for the work on which it is to be used. Light weight heads are usually driven by a standard taper shank, while those intended for heavy work are clamped to the quill and driven by a key inserted in the drift slot of the spindle.

Electric Contactor Controller: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A Type S contactor controller, intended for starting and regulating the speed of shunt-series, and compound-wound direct-current motors used on cranes, hoists, crushers, roll and transfer tables, etc. This controller will operate in any position, as the contactors are spring-actuated, and therefore not affected by gravity.

Slotting Machine: Racine Tool & Machine Co., Racine, Wis. A No. 25 slotting machine which has a table measuring 12 by 27 inches. The machine makes 60 strokes per minute, with a length of stroke of 7 inches. The main working parts of the mechanism and the reservoir for the coolant are contained in the base. The feed is governed by a spring-controlled lever which can be regulated from the front of the table.

Nut and Screw Driving Machine: Spencer K. Brown, Syracuse, N. Y. A nut and screw driving machine designed to turn at the rate of 1000 revolutions per minute, which is now used in the assembling department of the H. H. Franklin Mfg. Co., of Syracuse. This machine is the invention of Mr. Brown who is associated with the above company. However, plans for the manufacture of this machine have not been decided upon.

Magnetic Testing Apparatus: A device for the magnetic testing of steel, known as the "Defectoscope" and invented by Dr. Charles W. Burrows, magnetic research engineer, Grasmere, N. Y. This device is especially adapted for use in determining defects in steel wire, rods, rails, cables, and strips. It is also useful in determining whether or not the piece under test is of the same magnetic characteristics as the original sample.

Portable Electric Drill: Arnold Electric Tool Co., Inc., 902 Chapel St., New London, Conn. The Arnold Type C portable electric drill, which is provided with a 1/3-horsepower motor having an idle speed of 480 revolutions per minute. This tool will drill ½-inch holes in steel and ¾-inch holes in wood or brass. The motor operates on both alternating and direct current of 110 to 120 volts, although machines can be furnished for other voltage.

Tier-lift Truck: Lakewood Engineering Co., Cleveland, Ohio. In the February number of MACHINERY mention was made of a tier-left truck made by this company. An improved model No. 703-A built along the same general lines has recently been brought out. It has a lifting range of 96 inches and has double the lifting speed of the truck previously described. This truck is designed especially for handling light bulky packs having a total weight of not over 2000 pounds.

Arbor Press: P. A. Geier Co., Cleveland, Ohio. A general utility arbor press designed for use in garages, repair shops, and machine shops. This press has a hardened steel pinion which meshes with an 8/10 pitch stub tooth steel rack. The height of throat over the plate is 13¾ inches, the largest arbor opening 2 inches, and the maximum diameter of the work which can be accommodated is 33 inches. The operating lever is 22½ inches long, and with the compound mechanism gives a leverage of 160 to 1; with the compound mechanism out the leverage is 40 to 1.

Electric Chain Riveting Machine: Kobert Machine Co., Buffalo, N. Y. A machine for automatically riveting sprocket chain links. The links are fed from a rotating hopper, having a screw and worm rail within the hopper body which feeds the links directly into the welding fixture. The jaws then close on the work, the electrode makes contact in a manner which permits no sparking or arcing, and when the desired heat is obtained, the electrode is raised and a heading set delivers a heavy blow, thus forcing the metal into the desired shape.

Magnetic Separator: Dings Magnetic Separator Co., 672 Smith St., Milwaukee, Wis. A Type B magnetic separator intended for extracting iron from brass and aluminum chips, abrasive materials, rubber buffings, etc. The machine has an electromagnet with poles located above two cross-belts, which travel above a wide belt containing the material to be separated. The cross-belts carry the particles which are raised by the magnetic poles to the side of the machine, whence they drop into receptacles placed to receive them. The machines are built in five sizes with conveyor belts from 18 to 60 inches in width.

Metal-spinning Lathe: P. Pryibil Machine Co., 512-524 W. 41st St., New York City. A metal-spinning lathe of the extension-bed type, which is intended for the spinning of articles of large dimensions, such as utensils for restaurant kitchens. The headstock is provided with a cone pulley and back-gears. With the gap closed, the swing is 27 inches, and with the bed extended, 60 inches. A compound slide-rest is provided, which can be set to any position. The longitudinal feed is 16 inches and the cross feed 9 inches. Faceplates measuring 20 inches and 12 inches are provided. The net weight of the machine is 4500 pounds.

Grinding Machine: B. L. Schmidt Co., Davenport, Iowa. A "Micro" semi-automatic 19- by 24-inch internal grinding machine, having provision for wet grinding. It grinds holes from 2½ to 10 inches in diameter and up to 13 inches long. There are two wheel-spindle speeds of 5500 and 3652 revolutions per minute; and the planetary speeds are 48 and 25 revolutions per minute, with table speeds 11, 6½, 5¾, 4⅝, 3⅝, and 2½ inches per minute. The headstock is mounted on the bed, and the table travels under it. The spindle has an eccentric motion, variable from 0 to 1⅛ inches, and it is possible to feed in units of 0.0001 inch by means of push-buttons on the headstock.

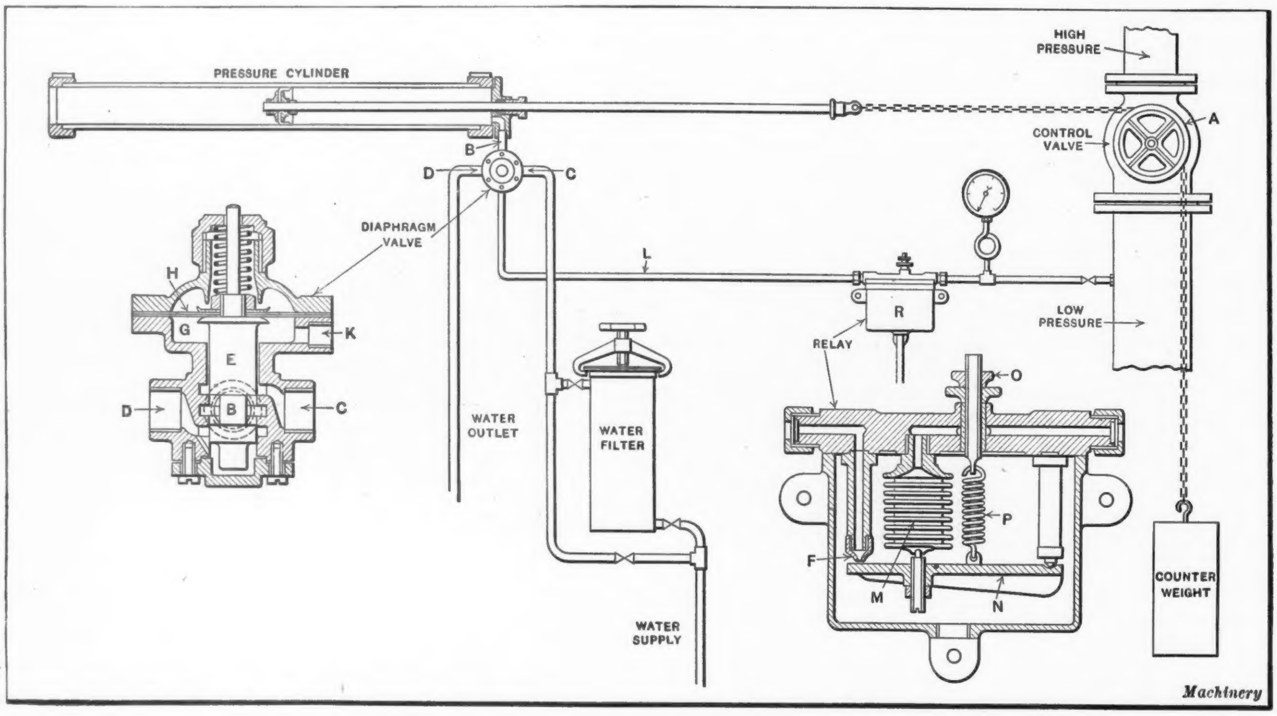
Oil-burning Furnaces: Wayne Oil Tank & Pump Co., Fort Wayne, Ind. A line of tilting non-crucible type oil-burning furnaces for melting brass, copper, aluminum and other non-ferrous metals. These furnaces are built in two sizes having capacities of 350 to 550 and 550 to 800 pounds, respectively. Air at a pressure of about 1½ pounds and oil at 5 pounds or more pressure is required to operate the burners. This company has also brought out a tilting crucible-type oil-burning furnace made in three sizes, having capacities of 200, 350, and 750 pounds, respectively. A worm-gear drive is provided for tilting, and its action serves to lock the furnace in any position. The burner is designed for air pressure of from 1 to 2 pounds, and an oil pressure of 5 pounds or more.

ARCA AUTOMATIC REGULATING APPARATUS

An ingenious regulating apparatus which is especially designed for maintaining constant pressure of steam, air, gas, water or other fluids, or for obtaining a constant temperature or a constant electromotive power has been developed by a Swedish inventor by the name of Ragnar Carlstedt. The regulating device is based upon a well-known hydrostatic law. The simplest method of explaining how the regulating apparatus functions will be to take an actual example as shown diagrammatically in the illustration. Here the apparatus is used for controlling the flow of steam, and actuates through a sprocket wheel *A*, the control valve on the steam line. The sprocket wheel is substituted for the handwheel on an ordinary globe valve, and a chain passes over the sprocket wheel to a counterweight as shown at its lower end, while the other end of the chain is connected to a piston-rod, the piston of which is moved by hydraulic pressure in the cylinder. It is evident that a movement of the piston in the pressure cylinder caused by the operation of the regulating mechanism will open or close the globe valve, because if the pressure in the cylinder is reduced, the counterweight will pull the piston toward the right and open the valve, while if the pressure on the piston is increased, it will close the valve against the action of the counterweight.

The pressure of the water in the pressure cylinder is controlled by a diaphragm valve, this valve being shown in section on an enlarged scale. The valve is connected at *C* with a water supply line, and at *D* with a water outlet. It is connected to the pressure cylinder by port *B* and to the relay *R* by piping *L* which enters the valve at port *K*. The relay *R* is connected, in turn, with the low-pressure side of the steam system to be regulated, and controls the pressure of the water in chamber *G*. The manner of operation will be described later. If there is a variation in the pressure of the water in chamber *G* a movement of valve piston *E* will be produced due to the action against diaphragm *H*, and thereby either the port *C* or *D* may be closed. The spring on the opposite side of this diaphragm makes it possible to adjust to the exact amount of pressure that is wanted to cause a given movement, this adjustment being made through suitable nuts. The pressure in chamber *G* causes water to be constantly forced to the relay, where it escapes through an orifice.

A section through the relay is shown on an enlarged scale in the lower right-hand corner of the illustration. The construction of the relays used in different installations of this regulating system varies, but the basic principle whether for pressure, heat-controlled electric current regulation, etc., is the same. The relay regulates the amount of water that escapes from pipe *L* through orifice *F*, and thus controls the pressure in chamber *G*. Close to the mouth of orifice *F* is the end of the pivot lever *N* which may be drawn by varying force against the metal bellows *M*, by coil spring *P*, which is adjusted by the nut *O*. The variations of the pressure in the low-pressure side of the steam line cause the bellows to expand and contract, thus causing slight movements of the lever. When the end of the lever is moved away from orifice *F*, the pressure behind the jet is automatically decreased, and when the lever is moved closer to the orifice, there is an increase in the hydrostatic pressure behind the jet. Hence, the pressure in chamber *G* is automatically increased or decreased with the variations in the low-pressure steam line, and suitable movements of valve piston *E* are obtained as previously described.



Automatic Regulating Apparatus for controlling Pressure of Fluids and Gases

The action of the entire apparatus is as follows: When the pressure in the steam line increases, the bellows expand and force lever *N* downward, permitting an increased flow of water through the orifice *F*, and thereby reducing the pressure in chamber *G* of the diaphragm valve and causing a movement of piston *E* so that port *C* is closed and port *D* opened. This allows water to be discharged from the pressure cylinder, thus reducing the pressure in the cylinder and allowing the counterweight to close the globe valve sufficiently to compensate for the rise in pressure of the steam. In like manner, a decrease on the low-pressure side of the steam line causes the bellows in the relay to contract, thereby bringing end of lever *N* closer to the orifice. This increases the hydrostatic pressure behind the orifice, increases the pressure in chamber *G*, opens the supply port *C* and closes port *D*, and thereby increases the pressure on the piston in the pressure cylinder, pushing it to the left and opening the globe valve against the action of the counterweight.

The characteristic of the relay employed in electric installations is the utilization of the law of expansion. This relay is used in connection with a rheostat for obtaining the proper current supply, and operates on the same basic principle as the relay previously referred to. It consists of an outer brass tube in which a glass or porcelain tube is con-

tained, and the impulse for actuating the water jet is derived from the difference in the coefficient of expansion of the two materials from which the tubes are made. These relays are suitable for temperatures up to about 390 degrees F. For higher temperatures up to 1100 degrees F., the outer tube is made of nickel. The electric relays are capable of handling any amperage or flow of electric current.

There are two types of relays for pressure regulations, one for high pressures from 2 to 300 pounds per square inch, and one for low pressures. The high-pressure relay is the one described in the preceding paragraphs, and the design of the low-pressure relay makes use of a canvas diaphragm in place of the bellows mentioned in connection with the high-pressure relay. In addition to the usages referred to, this regulating system may be employed for a diversity of purposes, such as regulating furnace drafts, for dryer installation in automatically controlling the moisture, for heat-treating furnaces, and numerous other commercial purposes.

Only a very slight impulse is required to actuate the movement of the pressure cylinder piston, it being stated that the regulator will operate with a very slight variation in the water jet. For example, it is pointed out that often a movement of only a few thousandths of an inch of the lever which controls the water jet will operate the pressure cylinder piston. The apparatus is handled in this country by the American Galco, Inc., Grand Central Palace, New York City.

* * *

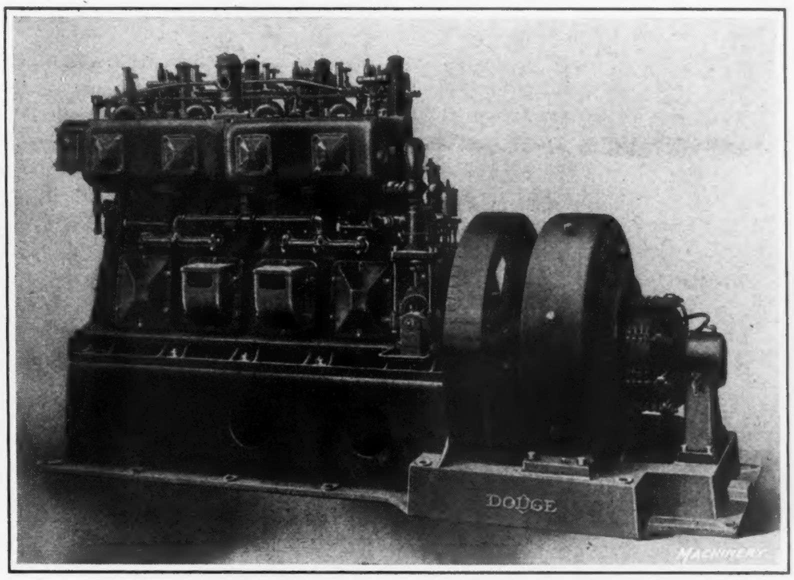
FORTIETH ANNIVERSARY OF A. S. M. E.

On November 5, 1880, a meeting of engineers was held at the Union League Club in New York City for the purpose of organizing an association of mechanical men which was given a name that is now well known in engineering circles —the American Society of Mechanical Engineers. To commemorate the fortieth anniversary, a meeting was held in the Engineering Societies Auditorium at 29 W. 39th St., New York City. Meetings were also held simultaneously by all of the local sections of the society. One of the features of these meetings consisted of the demonstration of a contribution to applied science made by W. H. Bristol, president of the Bristol Co., Waterbury, Conn. Mr. Bristol has been successful in developing a practical means for synchronizing the operation of a moving picture machine and a phonograph, making it possible for a speaker to be shown continuously on the screen while the phonograph reproduces his words in time with corresponding gestures. Fred J. Miller, president of the American Society of Mechanical Engineers, and Ira N. Hollis, past president, went to Waterbury for the purpose of having records made that could be distributed to all of the sectional meetings to convey the greetings of these two distinguished members of the society, and to show them while making their speeches. Unfortunately, time did not permit of sending out the required moving picture equipments for the purpose, but the phonograph records were used. At the New York meeting the chief speakers of the evening were Fred J. Miller, president of the American Society of Mechanical Engineers; J. Herbert Case, acting governor of the Federal Reserve Bank, New York City; Samuel Gompers, president of the American Federation of Labor; and William B. Dickson, vice-president of the Midvale Steel & Ordnance Co. Representatives were in attendance from the Institution of Mechanical Engineers of Great Britain, the American Society of Civil Engineers, and the American Society of Mining Engineers.

* * *

DODGE ELECTRIC GENERATING APPARATUS

One of the latest developments of the Dodge Sales & Engineering Co., Mishawaka, Ind., is shown in the accompanying illustration. It consists of an electric generator driven by a Dodge heavy oil engine. The units may be furnished with the engine connected directly to the generator as shown, or may be equipped for belt drive. The sizes at present manufactured range from 12½ up to and including 75 horsepower. The Dodge engine is sold under a standard guarantee which specifies a consumption of fuel oil of 0.5 pound per brake horsepower hour, using fuel as low as 0.28 degree Baumé test, containing not less than 18,500 British thermal units per pound. The engine here illustrated has a brake output of 50 horsepower, and is direct-connected to a 30-kilowatt, 220-volt, direct-current generator, running at a normal speed of 425 revolutions per minute. The cost of producing current with this equipment is said to be five mills per kilowatt hour, basing the cost of fuel at five cents per gallon.



Dodge 50-horsepower Electric Generating Unit

The generator was developed especially for this particular service by the Engberg Electrical & Mechanical Works, St. Joseph, Mich. The armature is of the iron-clad ventilating type with a laminated core, being built of electrical sheet steel, thoroughly japanned before being assembled. The drum and core are provided with air ducts which permit a thorough circulation of air. In the type shown, the crankshaft coupling is connected directly to the armature drum, so that the engine drives through the armature and not through the armature shaft. This construction enables the armature to be removed without disturbing the engine.

The commutator is made of copper bars insulated with a high-grade mica plate and it is of heavy construction, thus insuring continuous operation without need of renewal. It is built up on a separate sleeve, and bolted to the armature drum, so that the shaft can be removed without disturbing the windings. The bars are collected in a steel chuck, which is provided with large steel screws. In assembling, the chuck is heated and allowed to expand, at which time the screws are tightened so that when the chuck cools and shrinks, the commutator is held tightly in place.

* * *

The monthly statements of the Interstate Commerce Commission show that from March 1 to September 1 of this year the railroads expended approximately $175,000,000 more on maintenance of roadway and structures than during the corresponding period last year.

STRENGTH OF SPUR GEARS

A chart developed in the engineering department of the Foote Bros. Gear & Machine Co., Chicago, Ill., to simplify the calculations involved in figuring the strength of spur gears is shown in the illustration. This chart is based upon the well-known Lewis formula that is given on page 595 in MACHINERY'S HANDBOOK, and gives the safe working load in pounds per inch of face at the pitch line of cast-iron gears when the velocity at this line is zero. The safe working load at any velocity can then by determined by the method described in the following. A tensile strength of 8000 pounds per square inch is used in constructing the chart, this being suitable for cast-iron gears with cut teeth. In order to find the safe working load of unhardened steel gears, the values obtained by the chart should be multiplied by 2.5, and to find the safe working load of hardened steel gears the values should be multiplied by 4.

In using the chart, the safe working load of the gear, in pounds per inch of face, when the velocity equals zero is determined by following the vertical line corresponding to the number of teeth in the gear to its intersection with the curved line representing the pitch of the gear teeth, and then following the nearest horizontal line at the point of intersection to the left side of the chart. The value obtained should next be multiplied by the face width of the gear in inches. This last value is multiplied by a certain factor, which is dependent upon the velocity of the gear, to find the safe working load of the gear when the velocity in feet per minute is known. This velocity V can be readily found by multiplying the product of the pitch diameter in inches times the number of revolutions per minute by the constant 0.262. The factors referred to in the foregoing correspond-

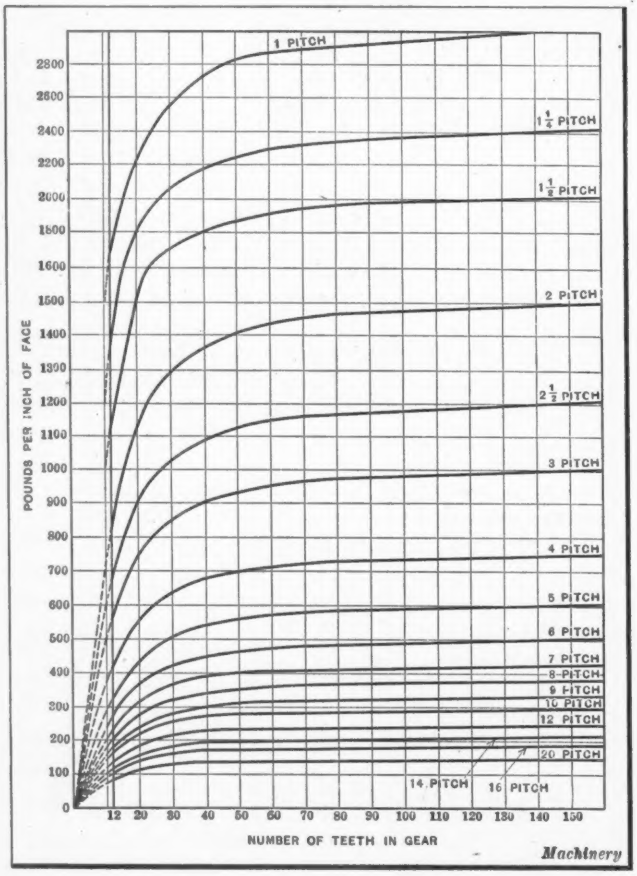


Chart giving Safe Working Load of Spur Gears in Pounds per Inch of Face when the Velocity equals Zero

ing to various velocities are given in the accompanying table. When the safe working load W of a given velocity is known, the horsepower can be calculated as follows:

$$\text{H.P.} = \frac{V \times W}{33{,}000}$$

As an example, assume that it is desired to find the horsepower of a 20-tooth hardened steel spur gear of 2½ diametral pitch, having a face 4 inches in width and rotating at the rate of 600 revolutions per minute. By following the vertical line of the chart corresponding to 20 teeth until it intersects with the 2½-pitch curved line, and then following the horizontal line passing through this point of intersection to the

TABLE OF STRENGTH FACTORS

Velocity, Feet per Minute	Factor	Velocity, Feet per Minute	Factor
50	0.928	600	0.500
100	0.857	900	0.400
200	0.750	1200	0.333
300	0.666	1800	0.250
450	0.571	2400	0.200

Machinery

left side of the chart, the safe working load per inch of face width will be found to be 900 pounds. Multiplying this value by 4 gives a safe working load of 3600 pounds for the entire face width, provided the gear is made of cast iron. However, as the gear is made of steel and hardened, this value must also be multiplied by 4, so that 14,400 pounds equals the safe working load of the gear, assuming that the velocity at the pitch line equals zero. The velocity of the gear is equal to 8 × 600 × 0.262, or 1257 feet per minute. The factor in the table corresponding to the nearest velocity, which is 1200 feet per minute, is 0.333. The safe working load of the gear at the given velocity therefore equals 0.333 times 14,400 or 4800 pounds. By substituting the proper values in the horsepower formula:

$$\text{H.P.} = \frac{1200 \times 4800}{33{,}000} = 175$$

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1920.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the treasurer and general manager of The Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Erik Oberg	" " " " "
Managing Editor, None	" " " " "
Business Managers:	
Alexander Luchars, President	" " " " "
Matthew J. O'Neill, Treasurer and General Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "
H. L. Ketchum	" " " " "
E. Y. Urban	" " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 29th day of September, 1920.

WILLIAM E. BACON,
(SEAL) Notary Public, Kings County, No. 522.
Kings Register, No. 1279.
New York County No. 747
New York Register No. 1673
(My commission expires March 30, 1921.)

PERSONALS

D. B. Carson has been appointed Cleveland district sales manager for the Tacony Steel Co., Philadelphia, Pa.

D. J. Crowley has been appointed Michigan sales agent of the Tacony Steel Co., Philadelphia, Pa., and will be located in the Dime Bank Bldg., Detroit, Mich.

C. W. Angerman, for six years chief draftsman for the Griscom-Russell Co., Massillon, Ohio, has entered the employ of the Lucius Mfg. Co., Canton, Ohio, as chief mechanical engineer.

W. B. Currier, Jr., has been appointed general manager of the Cleveland Planer Co. and the Cleveland Machine Tool Co., Cleveland, Ohio. Mr. Currier replaces D. B. Clark who is no longer connected with either concern.

W. H. De Wolfe has recently been appointed district manager of the New Britain Machine Co., New Britain, Conn. Mr. De Wolfe's headquarters will be in Boston, Mass., at Room 638, Old South Bldg., 294 Washington St.

William Hartman, superintendent of the National Cash Register Co., Dayton, Ohio, has been elected a member of the board of directors of that company. Mr. Hartman has been in the employ of the company for thirty years.

A. H. Ackerman has been appointed district sales representative of the Tacony Steel Co., Philadelphia, Pa., succeeding F. B. Hillwick. The offices have been removed from the Marquette Building to 427 Reaper Block, Chicago.

G. E. Anderson, formerly assistant eastern sales manager of the Duff Mfg. Co., Pittsburg, Pa., has been promoted to the position of southwestern sales manager, and placed in charge of the new branch office of the company located in the Railway Exchange Bldg., St. Louis, Mo.

Frederick T. Davis is now connected with the New York branch office of the Becker Milling Machine Co, Reed-Prentice Co., and Whitcomb-Blaisdell Machine Tool Co., located at Grand Central Palace, New York City. Mr. Davis was formerly with the Davidson Tool & Mfg. Corporation.

C. F. Meyer, assistant secretary of the Landis Machine Co., Waynesboro, Pa., will leave shortly for an extended trip to the Orient in the interests of the company. Mr. Meyer will visit England, India, The Dutch East Indies, Australia, Philippine Islands, China, Japan, and Hawaii.

Ralph K. Rowell, formerly equipment engineer at the International Motors Corporation, has become a director and vice-president of Hubbard & Harris, Inc., Bridgeport, Conn., consulting engineers. His attention will be given particularly to the work of the machine and equipment designing department.

R. H. Bowyer, formerly factory manager of the Dittmer Gear & Mfg. Corporation, Lockport, N. Y., has been appointed sales engineer. George E. Wilkinson, formerly chief inspector, will take Mr. Bowyer's place as factory manager. E. L. Sherman has been promoted to the position of supervisor of inspection.

J. F. Boyd, formerly with the Cyclops Steel Co., has been placed in charge of sales of the Wetmore expanding reamers in the Chicago district, which includes Illinois, Missouri, and northern Indiana. Mr. Boyd's office is at 846 Marquette Bldg., Chicago, Ill. The Scully-Jones Co. will continue to handle Wetmore products as heretofore.

L. C. Wilson, for the last two years general sales manager of the Chain Belt Co., Milwaukee, Wis., has been elected secretary of the Federal Malleable Co., West Allis, Wis., manufacturer of malleable castings, malleable chain, and the "Rapid" molding machine. He will be succeeded as sales manager of the Chain Belt Co. by Clifford F. Messinger.

George H. Morgan has been elected treasurer of E. F. Houghton & Co., Philadelphia, Pa., manufacturers of oils and leathers. The position of secretary, formerly held by Mr. Morgan, will be filled by George W. Pressell, chief of the Houghton Research Staff. Mr. Morgan will retain the position of managing director of the leather manufacturing department of the company.

Albert H. Hopkins has resigned from the presidency of the Engineering Advertisers' Association of Chicago and from the managership of the advertising and sales promotion departments of the C. F. Pease Co. to become Chicago manager for the J. Roland Kay Co., 161 E. Erie St., Chicago, Ill., international advertising agent. He will have charge of the domestic division of the company.

E. P. Williams, formerly director of field work, Bureau of Market Analysis, Inc., has become associated with the Independent Pneumatic Tool Co., Chicago, Ill., manufacturer of "Thor" air and electric tools. Mr. Williams will have charge of the Direct by Mail Advertising and Sales Promotion Department of the company and will be located in the general offices at 600 W. Jackson Blvd., Chicago.

J. J. Arnsfield, advertising manager of Fairbanks, Morse & Co., was elected president of the Engineering Advertisers' Association of Chicago, to fill the vacancy made by the resignation of A. H. Hopkins; Keith J. Evans, advertising manager of Joseph T. Ryerson & Son, was elected vice-president; and Julius Holl, advertising manager of the Link-Belt Co. was elected a member of the board of directors.

Walter Watson, who has been in the continuous employ of the Watson-Stillman Co. for fifty years, was presented on November 1, by the directors of the company, with a check for $1000 as an expression of appreciation of his long and faithful services as a highly skilled machinist. In addition, the company agreed to pay Mr. Watson, upon his voluntary retirement from employment, the sum of $65 a month during his life, and on his death to pay to his wife $50 a month throughout her life.

Albert A. Dowd, formerly president of the Service Engineering Co., 25 Church St., New York City, is no longer connected with that company. Mr. Dowd has formed another company, which will operate under the name of Albert A. Dowd Engineering Co. Offices and drafting-rooms will be maintained at 131 W. 39th St., New York City. The new organization is prepared to handle work in the following lines: Planning, consulting, factory investigations, industrial engineering, design of tools, design of automatic machinery, and building of tools and automatic machinery.

Fritz J. Frank has been elected president of the Iron Age Publishing Co. to succeed W. B. Taylor who recently retired on account of ill health, aften ten years able and vigorous administration. Mr. Frank was born in Pennsylvania in 1872, and in 1898 became western business manager of the *Colliery Engineer*, a publication well known at that time in the coal mining field. In 1906 he left the *Colliery Engineer* and became connected with the *Mining & Scientific Press*, continuing there until 1910 when he came to the *Iron Age* as advertising manager in the New York territory, being made secretary in 1911 and since 1918 vice-president of the Iron Age Publishing Co. Mr. Frank's twenty two years' experience in technical journalism, and particularly in the iron, steel, and machinery industries, qualifies him unusually well for his present position at the head of the Iron Age organization. He has many friends in those industries as well as in the publishing field who join in wishing him success as the responsible head of a great journal with sixty-five years of history behind it.

Fritz J. Frank

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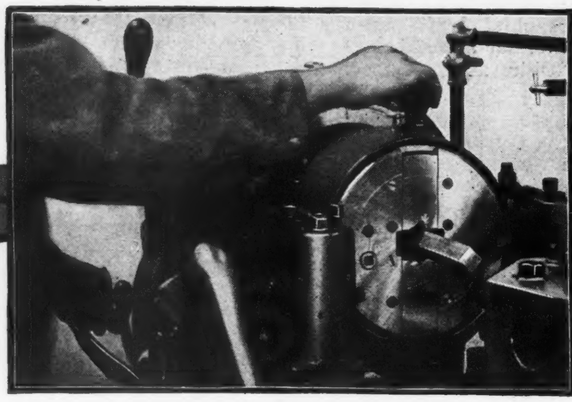
SOCIETY OF INDUSTRIAL ENGINEERS' MEETING

The Society of Industrial Engineers held its annual fall convention in Pittsburg, November 10 to 12. The keynote subject of the convention was Industrial Education. Among the speakers at the convention were Frank B. Gilbreth, of Frank B. Gilbreth, Inc., Montclair, N. J., who spoke on "Some New Factors in Industrial Education"; M. O. Leighton, chairman National Public Works Department Association, Washington, D. C., who spoke on "The Need for the Application of Industrial Engineering Principles in National Affairs"; H. H. Merrick, president Great Lakes Trust Co., Chicago, who spoke on "Training Managers to Apply Business Principles"; Dwight T. Farnham, St. Louis, who spoke on "European Industrial Conditions"; E. L. Ryerson, Jr., vice-president and works manager Joseph T. Ryerson & Son, Chicago, who spoke on "Training Industrial Engineers within the Organization"; and William O. Lichtner, Thompson & Lichtner, Boston, who spoke on "Methods of Training Time Study Men." The business manager of the society is George C. Dent, 327 S. La Salle St., Chicago, Ill.



Two distinctive features that give

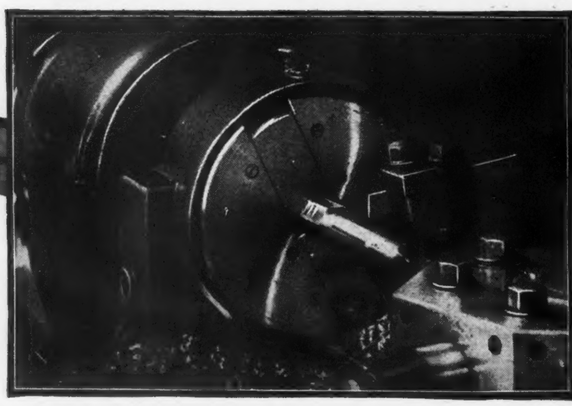
BROWN & SHARPE

Wire Feed Screw Machines

such great flexibility are the Roller Feed and the Automatic Chuck.

The **Roller Feed** is located near the front spindle bearing. This construction brings the feed rolls very close to the chuck, so that each bar is used practically to the end.

The rollers will feed any length without adjustment, and will accommodate any size stock within the capacity of the machine.



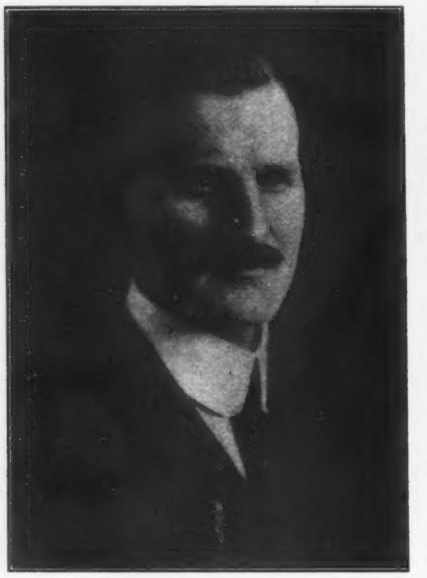
Brown &

Mfg.

Providence,

EDWIN S. CARMAN NEW PRESIDENT OF THE A. S. M. E.

Edwin S. Carman, works manager of the Osborn Mfg. Co., Cleveland, Ohio, has been elected president of the American Society of Mechanical Engineers for the coming year, taking office at the annual meeting, December 8. Mr. Carman was born in Prairie Depot, Ohio, in 1878, and his high-school education was supplemented by engineering studies at the Central Manual Training School of Cleveland. He gained his early training in industrial mechanical work in the shop of the Sun Oil Co., Toledo, Ohio, and four years later came to the American Machine & Mfg. Co., Cleveland, where, after two years in the engineering department, he was appointed chief engineer. While with this company he designed a complete line of electric traveling and forge shop cranes, hoists, and rolling mill equipment. In 1908 this company was consolidated with the Johnston & Jennings Co., of Cleveland, and Mr. Carman was appointed chief engineer and manager of the engineering and machine department.



Edwin S. Carman

The Osborn Mfg. Co. of Cleveland early recognized the possibilities of making foundry molding machinery, and decided to enter this field. In 1908, Mr. Carman was engaged by this company to design, manufacture and build a complete line of foundry molding machines. In 1913 Mr. Carman became directly associated with the Osborn Mfg. Co. as chief engineer in charge of engineering and manufacture of the machine division, and in 1916 he was elected a director and secretary. In 1917 he was appointed works manager of both the machine and brush divisions of the company. He is the author of a treatise on "Foundry Molding Machines and Pattern Equipment," and a contributor of papers on the art of machine molding.

For a number of years Mr. Carman has been prominent in the activities of engineering societies. He has been president of the Cleveland Engineering Society. He was the first chairman of the Cleveland Section of the American Society of Mechanical Engineers, and was a member of the A. S. M. E. Committee on Aims and Organization and chairman of Sub-committee C, which dealt with relations of the mechanical engineer to other engineers. He is a member of the A. S. M. E. Committee on Constitution and By-laws. Last December he was appointed chairman of the A. S. M. E. Committee on Local Sections, with a seat on the council.

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OBITUARIES

James W. Bell, vice-president of the Wagner Electric Mfg. Co., St. Louis, Mo., died at his home in St. Louis, November 4, aged ninety-four years. He had been a director and stockholder of the company since its incorporation. Mr. Bell had many other interests, and is given credit for having introduced the first comprehensive cost system in the stove industry.

A. J. Babcock, president of Manning, Maxwell & Moore, Inc., died in London, England, on October 30 after a short illness. Mr. Babcock was born in Brookfield, N. Y., in 1850, served in the regular army from 1867 to 1871, then studied and practiced law until 1884, when he entered the machinery business in Chicago with the Fay & Egan Co. Later he became connected with Manning, Maxwell & Moore as manager of their Chicago branch, and about seven years ago came to New York as assistant to the president. He later became president himself, retiring in May, 1920, on account of ill health.

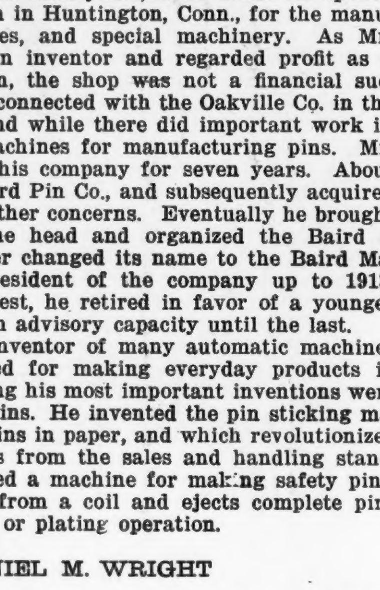
Arthur E. Hauck, president of the Hauck Mfg. Co., Brooklyn, N. Y., died at his home in Flatbush, October 30, aged 41 years. Mr. Hauck began his career by learning coppersmithing in Germany, but subsequently left Germany to follow his trade in the Navy and shipyards of Belgium, France, and England. When he was twenty years old he came to this country and obtained employment in the Philadelphia Navy Yard. After working for three years in the Navy coppersmithing shops in Philadelphia, Norfolk, Baltimore, and Brooklyn, he started in the oil burner business in 1902 with a small shop in Brooklyn. This business has consistently grown and developed until it includes more than a score of basic patents in burning oil, kerosene, etc., as well as numerous minor inventions and improvements which deal with applications of burning oil for a great many uses.

Joseph H. Baird, founder of the Baird Machine Co., Bridgeport, Conn., died November 14 in Cheshire, Conn., aged ninety-two years. Mr. Baird was born in Oakville, Conn., in 1827. He started working at the age of ten and was first employed in the shop of the Scovill & Buckingham Co. of Oakville (now the Scovill Mfg. Co. of Waterbury), which was then manufacturing butt hinges and hardware. He remained with the firm for nine years, after which he opened a small shop of his own in Huntington, Conn., for the manufacture of tools, presses, and special machinery. As Mr. Baird was primarily an inventor and regarded profit as a secondary consideration, the shop was not a financial success. He later became connected with the Oakville Co. in the capacity of designer, and while there did important work in designing tools and machines for manufacturing pins. Mr. Baird remained with this company for seven years. About 1878 he formed the Baird Pin Co., and subsequently acquired an interest in several other concerns. Eventually he brought his interests under one head and organized the Baird & Warner Co., which later changed its name to the Baird Machine Co. He was president of the company up to 1913, when, at his own request, he retired in favor of a younger man, but he acted in an advisory capacity until the last.

Mr. Baird was the inventor of many automatic machines and improvements used for making everyday products in large quantities. Among his most important inventions were machines for making pins. He invented the pin sticking machine which puts the pins in paper, and which revolutionized the whole pin business from the sales and handling standpoint. He also invented a machine for making safety pins, which takes the wire from a coil and ejects complete pins ready for the cleaning or plating operation.

DANIEL M. WRIGHT

Daniel M. Wright, secretary-treasurer and general manager of the Henry & Wright Mfg. Co., Hartford, Conn., died in Hartford October 27, following an operation for meningitis. Mr. Wright was born in Philadelphia in 1870, but was educated in Hartford, Conn., and began his business career there. He became well known as a business man in Hartford and as a progressive machine tool manufacturer. He made several inventions, the most recent one being the new type of power press known as a "dieing" machine. Besides being general manager of the Henry & Wright Mfg. Co., he was president of the Universal Chain Co., and of the Claflin Oil Derrick Co. — corporations recently formed. He was also a director in various other enterprises and at one time was president of the Hartford Board of Trade, which was later merged with the Hartford Chamber of Commerce, of which Mr. Wright was at first vice-president and later president. In politics he was a Progressive, and was a delegate in 1912 to the convention which nominated Theodore Roosevelt for president. He was also a delegate to the national progressive convention in 1916, and a member of the progressive state central committee. He is survived by his wife, who was Mary Dedenar of Chicago; by two sisters, Miss Mary Wright and Miss Elizabeth Wright of New London; and by a brother, Marcus A. Wright of Tarrance, Cal.



Daniel M. Wright

COMING EVENTS

December 2-4—Annual meeting of the Taylor Society at the Engineering Societies' Building, 29 W. 39th St., New York City. Secretary's address: Room 611, 29 W. 39th St., New York City.

December 7-10—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

January 11-13—Annual meeting of the Society of Automotive Engineers in New York City. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

January 24-29—Third National Marine Exposition held at Grand Central Palace, New York City, under the auspices of the National Marine League of the United States of America, 268 Pearl St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Nebraska, Lincoln, Neb. Fiftieth annual general catalogue, containing the complete record for 1919-1920 and announcements for 1920-1921.

William Hood Dunwoody Industrial Institute, Minneapolis, Minn. Bulletins containing information concerning the institute and outlining the courses offered in the metal-working trades in both the day and evening schools.

Wentworth Institute, Huntington Ave. and Ruggles St., Boston, Mass. Circular containing an outline of the day and evening courses offered in the mechanical trades and in the manufacturing and architectural industries. There are two day courses covering a period of one and two years, respectively.

NEW BOOKS AND PAMPHLETS

Enamels for Sheet Iron and Steel. By J. B. Shaw. 88 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 165, of the Bureau of Standards. Price, 15 cents.

Cast Iron for Locomotive Cylinder Parts. By C. H. Strand. 25 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 172 of the Bureau of Standards. Price, 10 cents.

Modern Welding Methods. By Victor W. Page. 292 pages, 6 by 9 inches; 200 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

This book treats in detail of oxy-acetylene welding, thermit welding, and all classes of electric arc and resistance welding. The material is written in a simple, non-technical manner for the student and practical mechanic rather than the engineer. The purpose is to help those who are interested more in the practical applications than in the theory. The book shows the apparatus needed and its use. It describes the production of welding gases, and the construction and operation of all kinds of welding and cutting torches. Details are given concerning the methods of preparing work for welding. Gas and electric welding machines of different forms are described, and instructions are given for installing electric spot and butt welders. Cost data are also included. Soldering and brazing processes are described, and an outline of forge welding is given. The book contains instructions on the heat-treatment of steel as well as tabular data on tempering various forms of tools, melting points, and temperature determinations. The material is divided into nine chapters, headed as follows: Introduction to Methods of Joining Metals; Properties of the Common Metals; Welding Gases and their Production; Oxy-acetylene Welding Appliances; Oxy-acetylene Welding and Cutting; Electric Resistance and Arc Welding; Thermit and its Practical Applications; Soldering and Brazing Processes; and Forge Welding and Heat-treatment of Steel.

Hendrick's Commercial Register of the United States for Buyers and Sellers. Twenty-ninth annual edition, 1921. 2572 pages, 7½ by 9½ inches. Published by S. E. Hendricks Co., Inc., 2 W. 13th St., New York City. Price, $12.50.

The twenty-ninth annual edition of this comprehensive directory for buyers and sellers in the electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, chemical, railroad, steel, architectural, contracting, and kindred industries has just been published. The book has been thoroughly revised, the arrangement being the same as in previous editions. Following the index to trade classifications, which covers 163 pages and contains many cross-references, comes the classified trades section covering 1844 pages, an increase of 31 pages over the 1920 edition. This section contains over 18,000 classifications of different products, listed alphabetically, under each of which are given the names and addresses of the manufacturers, as well as detail matter, trade names, etc. The trade name section of the directory, which gives an alphabetical list of the important trade names and brands of products that are shown under the various classifications, contains 222 pages. This list of trade names furnishes a ready reference for purchasing agents and prospective buyers. The list of automobile trade names is given separately under the automobile classification in the classified trades section. The alphabetical section of the register, which follows the trade name section, covers 483 pages and contains a complete list of all the manufacturers whose products are included in the book, together with particulars of their main industry. In this section the address of the main office or works only is given, branch office and works addresses being given among the various classified lists. An alphabetical list of advertisers is also included. This list covers twenty-three pages, and gives the main office of each advertiser, as well as the domestic and the foreign branches. The same method of exterior indexing is employed as in the previous editions, the front edges of the pages being colored red, white, and blue to facilitate reference to any section.

Condensed Catalogues of Mechanical Equipment (1920 edition). 1004 pages, 6 by 9 inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $4.

This is the 1920 edition of a yearly publication comprising condensed and illustrated catalogue information covering the products of manufacturers of various classes of mechanical equipment and containing a general classified directory of mechanical equipment and a consulting engineers' directory. More firms than ever before are represented by the publication of catalogue data. The total number is 572, and among these are a large proportion of the leading manufacturers in their respective lines. The number of catalogue pages in this edition has also been increased to 745. The catalogue section is divided into seven main parts, as follows: Power Plant Equipment; Testing, Measuring and Recording Apparatus; Power Transmission Machinery; Conveying, Hoisting and Transporting Machinery; Metals, Alloys and Other Materials; Metal Work Machinery, Machine Tools and Accessories; and Compressors, Blowers, Pumps, Hydraulic Machinery, Industrial Machinery, Steel Plate Work. On the title page of each of the seven main divisions of the catalogue section is an alphabetical list of the products catalogued in that section, thus enabling the engineer to quickly find information concerning the equipment in question. For convenience, these separate lists are also combined in the main table of contents, which gives a general survey of the material in the volume. The products shown in the catalogue section are listed according to the names of the manufacturers, arranged alphabetically. The general mechanical equipment directory and the consulting engineers' directory which is compiled from the membership of the society, have been extended and improved, and it is believed that these reference features will prove of even greater value than heretofore. The mechanical equipment directory in this edition contains the names and addresses of more than 4000 firms listed under about 3000 classifications of equipment, and the consulting engineers' directory contains the names and addresses of 800 engineers listed under about 500 classifications.

NEW CATALOGUES AND CIRCULARS

Hobart Bros. Co., Troy, Ohio. Bulletin 52d, treating of HB ball-bearing electric motors, for operation on either alternating or direct current.

Lakewood Engineering Co., Cleveland, Ohio. Booklet illustrating the application of industrial transportation systems for different classes of work.

General Electric Co., Schenectady, N. Y. Bulletin 40017A, illustrating and describing small belted direct-current generators and exciters known as Type ML.

Dwight P. Robinson & Co., Inc., 125 E. 46th St., New York City. Circular illustrating power plants in different parts of the country that were designed and constructed by this company.

Metal Saw & Machine Co., Inc., Springfield, Mass. Circular illustrating and describing the "Horizontal Junior" metal-cutting machine of the band-saw type, which has a capacity for cutting metals up to 4 by 4 inches.

Baldwin Locomotive Works, 500 N. Broad St., Philadelphia, Pa. Records 98 and 99, illustrating and giving specifications for locomotives for heavy passenger service, and eight-coupled locomotives for freight service, respectively.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Stock list for November, 1920, of Shelby cold-drawn seamless steel tubing. Circular of "Meno" rust remover and cleanser for machines, tools, and all metal surfaces.

C. H. Boulin, 82 Duane St., New York City. Circular descriptive of the Hasler speed indicator, which indicates speeds of rotation from 1 to 10,000 revolutions per minute, as well as linear and circumferential speeds from 1 to 1000 yards per minute.

Esterline Co., Indianapolis, Ind. Circular reproducing power survey charts made by Esterline wattmeters, which revealed a defective condition of the reversing mechanism of a planer; waste of power by an air compressor; and defective condition of a circular saw.

Landis Machine Co., Inc., Waynesboro, Pa. Leaflet printed in Spanish illustrating and describing Landis pipe and bolt threading machines. The circular shows a number of different installations of these machines in various industrial plants and gives data regarding the work done in each case.

R. G. Smith Tool & Mfg. Co., Newark, N. J. Circular of the Smith standard radius lathe and planer tool, showing its application for cutting convex and concave radii. Prices are given for the different sets of tools furnished, which consist of various sizes of concave and convex cutters and a holder.

Karge-Baker Corporation, Phoenix, N. Y. Catalogue describing the principle of construction and details of design of the Karge cushion coupling. The five different types of Karge couplings are illustrated, and applications to various classes of drives are shown. The book is fully illustrated with both halftone and line engravings.

Metalwood Mfg. Co., Detroit, Mich. Circular B-63, illustrating and describing the Metalwood No. 597 shaft straightening press, which has a rated work pressure of from 50 to 60 tons. Circular B-67, describing the Metalwood No. 360 hydro-pneumatic swaging press, adapted to work requiring considerable pressure but a short stroke.

Milwaukee Electric Crane & Mfg. Co., Inc., Milwaukee, Wis. Catalogue of the Milwaukee crane, pointing out some of the principal features, describing the construction in detail, and illustrating the various types of trolleys produced. A large number of illustrations are included, showing installations of Milwaukee cranes in manufacturing plants.

Holz & Co., Inc., 17 Madison Ave., New York City. Bulletin 9, descriptive of Amsler standardizing boxes for checking tensile and compressive loads of testing machines of the lever or hydraulic types. Bulletin 10, describing in detail the operation of the Humfrey static notched-bar testing machine for measuring the brittleness and ductility of steel and other metals.

John Steptoe Co., Cincinnati, Ohio. Catalogue illustrating the Steptoe line of crank shapers, and milling machines of the hand and power type. The shapers are made in 14-, 16-, 20-, and 24-inch sizes, and the entire line has been strengthened to take exceptionally heavy cuts with high-speed steel. Applications of motor drive and single-pulley drive to Steptoe shapers are also shown.

Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. Catalogue covering the line of "Red-E" tools, which includes high-speed lathe centers, lathe dogs, grinding machine dogs, milling machine dogs, lathe tools, planer tools, hold-downs, and belt sticks. Tools of the "Red-E" line are made with removable high-speed steel cutters. The catalogue gives price lists of the various tools.

Norton Co., Worcester, Mass. Cloth-bound book containing articles by Howard W. Dunbar, dealing with the development and application of steadyrests in grinding operations; principles underlying form-grinding, and description of form grinding attachments; grinding of plane surfaces, including types of machines, selection of wheels, methods of handling work, and kinds of materials ground.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Catalogue 10, illustrating and describing the different styles of Mumford foundry molding machines made by this company. The various parts and the details of construction are clearly shown by a large number of line illustrations. Leaflets descriptive of the Hanna suction oiler, and the Mumford unbalanced type vibrator, respectively.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Catalogue 860, treating of C-H motor control apparatus for pumps, compressors, and similar service. A condensed chart is given to aid in the selection of the proper control equipment for each particular class of service. The booklet is illustrated with views showing installations of pumping and compressing machinery, and applications of control apparatus.

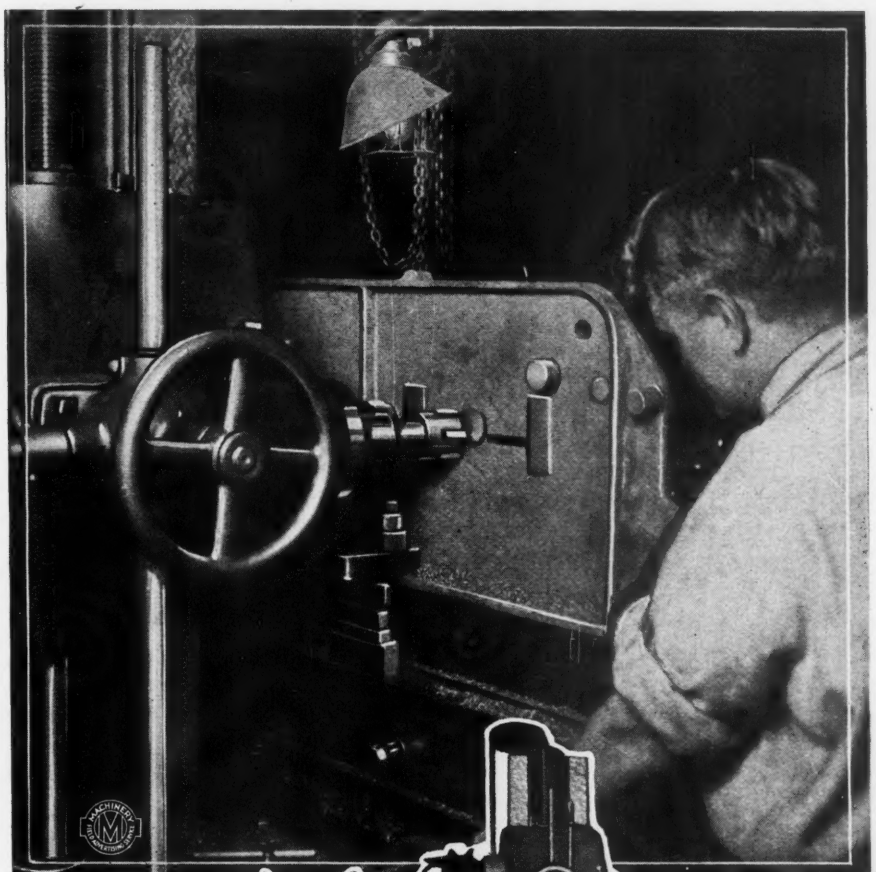
Joseph T. Ryerson & Son, Chicago, Ill. Folder entitled "Do You Know How to Make a Chisel?" describing in detail the making of a chisel from ¾-inch octagon tool steel, including the forging, grinding, hardening, and tempering. Illustrations are reproduced to show the correct form of the cutting edge of a chisel. The pamphlet also gives data relating to "Ryolite" 4-point chisel steel produced by this company.

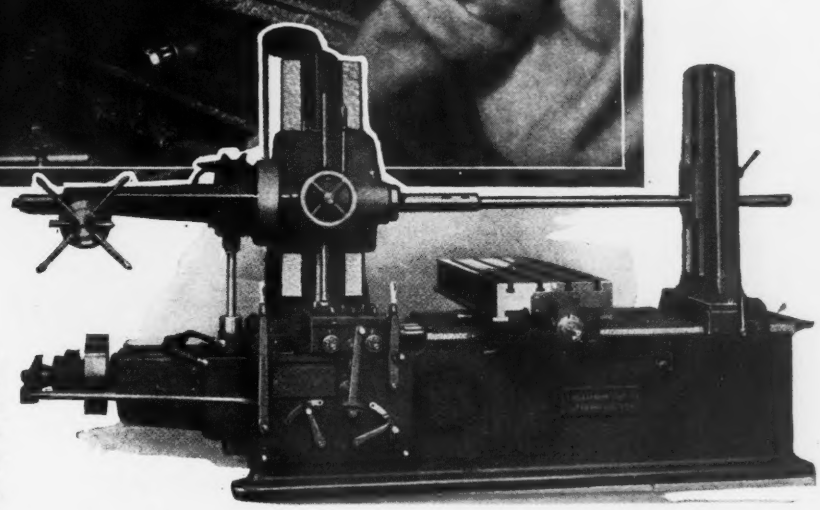
Sawyer-Weber Tool Mfg. Co., Los Angeles, Cal. Booklet entitled "Proof," containing information regarding the Weber re-turning method for refinishing crankshafts, and letters of recommendation from users of the Weber crankpin re-turning tool. The catalogue contains illustrations showing the tool at work re-turning crankshafts, a set of cutters for use with the Weber tool, chips indicative of the smooth cutting action of the tool, etc.

Ajax Metal Co., Inc., Philadelphia, Pa. Catalogue listing the complete line of Ajax metal products, which includes white metal alloys, bronze and brass ingots, and bearings and castings. This catalogue is published in two editions, one printed in English and one in Spanish, the growing export trade of the company having made necessary the publication in two languages. Copies of the booklet will be sent to all interested.

LUCAS "PRECISION"

Boring, Milling and Drilling Machines in the "Special Machinery" Business





Seven Years of Satisfactory Service

Machines to make good in this business must be highly versatile—designed to accommodate work of all shapes and sizes, conveniently adjusted and capable of working within close limits.

According to the Package Machinery Company, Springfield, Mass., Lucas "Precision" Boring, Milling and Drilling Machines have fully met all these requirements for the past seven years.

There are three in this shop. One of them is shown machining a cast-iron table for a soap wrapping machine—the operations involved being to drill and bore holes and face bosses on both sides of the piece. Let us describe them in detail.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U. S. A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne, V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

Eastern Tube & Tool Co., Inc., 594 Johnson Ave., Brooklyn, N. Y., is publishing "The Ettco Magazine," devoted to the interests of the company, which contains general articles, and material relating to the "Ettco" drill chuck, self-gripping mandrel, and high-speed insert center.

Western Machine Tool Works, Holland, Mich. Catalogue 21, illustrating and describing in detail Western low-hung drive plain radial drilling machines made in three styles known as the heavy, manufacturing, and leader types. The catalogue also illustrates and describes Western low-hung drive full universal radial drilling machines.

Fitchburg Machine Works, Fitchburg, Mass. Catalogue describing the construction and operation of the 4-inch "Lo-swing" lathe, which employs the principle of multiple tool turning for the rapid production of duplicate parts. The special equipment and attachments for use in connection with this machine are illustrated. A number of typical tool set-ups are shown diagrammatically, which indicate the wide field of work covered.

Davis-Bournonville Co., Jersey City, N. J. Bulletin descriptive of the No. 1A and No. 2 oxygraph for cutting steel up to 20 inches thick with oxy-acetylene or oxy-hydrogen, dies and shapes being cut accurately to drawing, pattern, or templet, with cutting speeds up to 18 inches per minute. The booklet contains examples showing a variety of shapes cut in electrical works, shipyards, navy yards, tool shops, and manufacturing plants.

Cincinnati Planer Co., Cincinnati, Ohio. Catalogue illustrating and describing the Cincinnati line of rapid-production boring mills, which are made in 42-, 48-, 60-, 72-, and 84-inch sizes, and massive boring mills made in 8-, 10-, 12-, and 10- by 16-foot sizes. Detailed views of the various parts of the machines are shown, and complete specifications, covering dimensions, capacity, weight, feeds, speeds, etc., are given for the different sizes.

Winter Bros. Co., Wrentham, Mass. Catalogue 14, containing dimensions, prices, and other data relating to the carbon and high-speed steel taps and dies made by the company. The leaves are provided with a thumb-index, so that any section can be readily referred to. The high-speed steel section of the catalogue is printed on colored paper. Tables of tap drill sizes, standard pitches for threads, decimal equivalents, and other useful information are included.

National Acme Co., Cleveland, Ohio. Circular showing the plants of the company at Cleveland, Ohio, Montreal, Canada, and Windsor, Vt., where Acme multiple-spindle automatic screw machines, bolt-threading machines, stud-threading machines, screw slotters, bar pointers, Gridley automatic screw machines, screw products, etc., are produced. Calendar for 1921, containing on each sheet an illustration of one of the company's automatic machines, and calendar for the current month as well as the past and following months.

L. S. Starrett Co., Athol, Mass. Catalogue 22, covering the line of mechanical tools made by the company, including steel rules, straightedges, section liners and protractors, steel measuring tapes, combination squares, bevel protractors, steel squares, calipers, vernier height gages, depth gages, micrometers, toolmakers' buttons, screw pitch gages, thickness gages, clamps, hacksaws, hacksaw frames, pliers, scribers, speed indicators, dividers, trammels, center-punches, screwdrivers, wire gages, bench levels, etc.

Landis Machine Co., Inc., Waynesboro, Pa. Handbook compiled for users and operators of Landis threading machinery, containing instructions relating to the grinding of Landis chasers and the care and operation of Landis die-heads and threading machines. The book also treats briefly of the application of the Landis die for cutting special threads. Tables of helix angles for different diameters and pitches, in inches and millimeters, are included, as well as tables giving maximum and minimum pitches for special threads, and widths of special chasers for special threads.

Ingersoll Milling Machine Co., Rockford, Ill. Catalogue entitled "Installations of Ingersoll Milling Equipment," illustrating the typical milling machines made by the company, and showing actual operations performed on these machines, which indicate the wide range of work for which they are adapted. The types of machines illustrated are the adjustable-rail milling machines, single-faced fixed-rail milling machines, double-faced fixed-rail milling machines, horizontal-spindle milling machines, and continuous milling machines of the rotary and circular table type, differential and drum types, and reciprocating type.

Brown & Sharpe Mfg. Co., Providence, R. I., has prepared a memorial booklet in recognition of the services of Brown & Sharpe employes during the war. The book is being distributed to the families of those who lost their lives, and to all the employes who could be reached of the 911 who were in service, as well as to several thousand employes now with the company who were also employed at the factory during the period of the war. The booklet contains portraits of the boys who lost their lives, an account of the service they rendered, as well as an honor roll of all the men in service, giving their length and branch of service, arranged by departments. Citations of distinguished service are included. A portion of the book is devoted to the service of the employes remaining in the factory who also made a worthy war record. The important work performed by the women who replaced the men entering the service is also given attention.

Joseph T. Ryerson & Son, Chicago, Ill. Bulletin entitled "How Safety Methods are Applied in the Ryerson Steel Service Plants," describing in detail the organization formed for the purpose of carrying on safety work in the Ryerson plants. The bulletin shows a safety organization chart which gives an idea of the extensive application of the work in these plants. It describes in detail the duties of the organization and the methods employed for awakening interest in safety work. A number of safeguards employed in the plants are shown. Bulletin boards are placed in prominent positions about the plants, on which are posted safety bulletins which are changed every day in order to maintain the workmen's interest. Safety meetings are held from time to time which the employes are invited to attend. The company realizes that the backbone of accident prevention is regular and frequent inspection, and hence every stock-room and piece of equipment is inspected once each week by members of the plant committee. The various plants of the company maintained at Chicago, New York, St. Louis, Detroit, and Buffalo compete with one another in the safety work. At the end of six months the plant which has the highest percentage standard is considered the prize winner, and every man in the plant who is eligible through length of service receives a reward in cash. Although it is difficult to determine the exact decrease in accidents in the Ryerson plants due to their rapid growth, a conservative estimate based on the yearly accident statistics places the reduction in the accident rate at 80 per cent.

TRADE NOTES

Dawson-Rouillard Tool Corporation, 51st St. and Lancaster Ave., Philadelphia, Pa., has changed its name to the **Dawson Tool Corporation**. The company has recently added the Wilkes tool-holder to its line of small tools, rivet sets, etc.

American Broach & Machine Co., Ann Arbor, Mich., has recently given out a contract for the erection of a new building, 50 by 120 feet, to be used for machine assembly. The building will be of one-story construction, similar to the present plant.

William Hamilton & Sons Car Co. has taken over the plant of the Jewett Car Co., at Newark, Ohio, where it will build and repair all classes of railroad and street cars. New equipment is being installed, and extensive alterations and additions are being made.

Chung Mei Trading Corporation, 2 Hongkong Road, Shanghai, China, would like to receive catalogues of all kinds of metal-working and wood-working machinery and tools. This firm is interested in introducing American machines and methods in China.

James Maher Pipe-Tongs & Wrench Co. has been incorporated in Delaware, Ohio, and is now engaged in the manufacture of Maher pipe tongs. The president of the company is James Maher; secretary and treasurer, M. G. Williamson; and general manager, G. A. Yocke.

Sun Machinery Co., Inc., formerly of 278 Washington St., Newark, N. J., has recently moved to larger quarters at 103 Commerce St., Newark. The new location affords adequate floor space to show the large stock of new and used machine tools and motors carried by the company.

Chicago Pneumatic Tool Co. announces the removal of its rock drill plant from 864 E. 72nd St., Cleveland, Ohio, to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. The location of the "Little Giant" air drill plant at 1241 E. 49th St., Cleveland, remains unchanged.

Lafayette Tool & Equipment Co., Inc., Lafayette, Ind., manufacturer of the Lafayette universal grinder, has appointed Russell, Holbrook & Henderson, Inc., sole agent for the company in the United States. Sales offices are maintained at 30 Church St., New York City, and 548 Leader News Bldg., Cleveland, Ohio.

Steel Products Engineering Co., Springfield, Ohio, has recently taken over the manufacture of the shaper formerly made by the H. J. Averbeck Shaper Co. It is the intention of the Steel Products Engineering Co. to continue the manufacture of the 17- and 21-inch sizes, and later to develop a 16-inch shaper for tool-room use, and a 25-inch shaper to take in a larger range.

Hubbard & Harris, Inc., Bridgeport, Conn., consulting and manufacturing engineers, at a recent meeting of the stockholders decided to change the firm name to **Hubbard, Harris & Rowell, Inc.** The officers of the concern are Harry E. Harris, president and treasurer; Ralph K. Rowell, vice-president; and H. B. Harris, secretary.

Bradford Sales Co., has been organized with offices in the Leader-News Bldg., Cleveland, Ohio, to represent in Cleveland and the surrounding territory manufacturers of mechanical or electrical products. C. C. Bradford, for a number of years sales manager of the U. S. Light & Heat Corporation, and more recently sales manager of the Marlin Rockwell Corporation, is manager.

Simonds Mfg. Co., of Fitchburg, Mass., and Chicago, Ill., has established a new company in Great Britain which will be known as **Simonds Saws, Ltd.** An office and shop has been opened at 53 Bayham, Camdentown, London, N. W., where a full line of Simonds saws steel products will be carried. Guy A. Eaves, formerly connected with the Fitchburg plant of the company, will be office manager, and Leon E. Wilbur, who has previously covered the Great Britain territory, will be associated with him.

Dillon Electric Co., Canton, Ohio, has completed a new plant at New Philadelphia, Ohio, 60 by 150 feet. This plant will enable the company to take care of their increasing business in the maintenance and repair work of electrical machinery and apparatus in the district adjoining New Philadelphia, and will also permit an expansion of the company's electrical grinder business. The plant in Canton will be operated as heretofore, but by having the two plants, a better service to customers in electrical maintenance and repair work becomes possible.

Wetmore Reamer Co., Milwaukee, Wis., announces that the Detroit branch office of the company has formed a new company to handle the sale of Wetmore expanding reamers in the state of Michigan, exclusive of the northern peninsula. James J. Ward, previously assistant sales manager, has become one of the three members of the new firm, which will be known as the **Wayman-Taylor-Ward Co.** Mr. Wayman and Mr. Taylor have previously handled this work. The location of the offices has been changed to 403 Real Estate Exchange Bldg., Detroit, Mich.

Kelly Reamer Co., Cleveland, Ohio, announces the following changes in its organization, coincident with moving into its new plant: A. H. Howard, who formerly operated an independent office as the A. H. Howard Sales Engineering Co., will represent the Kelly Reamer Co. in the Cleveland, Toledo, and northern Ohio territory; R. W. Martindale, formerly with the E. A. Harper Tool & Supply Co., of New York and Philadelphia, will handle the Pittsburg territory; W. B. Leonard, formerly of the Standard Tool Co., will have charge of the Buffalo territory; A. J. Wadsworth, formerly connected with the New Process Gear Corporation, has become associated with the service department.

Morse Chain Co., Ithaca, N. Y., manufacturer of the Morse rocker joint silent chain used on automobiles for power transmission, has established a branch factory in Detroit at Eighth and Abbott Sts., which will be given over exclusively to the manufacture of silent chain sprockets and the Morse adjustment. The Detroit branch will be under the general management of F. C. Thompson. F. M. Hawley will be chief engineer, and C. B. Mitchell, factory manager. The main plant at Ithaca will continue to manufacture chains and power transmission. The company would be glad to receive catalogues, booklets, and circulars of improved machines and equipment relating to the line of manufacture in which it is engaged.

Electric Furnace Co., Alliance, Ohio, reports an increasing demand for electric furnaces on the part of foreign users. The company has recently shipped two 105-kilowatt Bailey electric furnaces to Norway, where they will be used to melt zinc at the Jossingfyord plant in Stavanger, and to melt aluminum at the Norsk Aluminum Works at Christiania. Brass melting furnaces have also been shipped to the Amsinck Corporation of Mexico, Mitsui & Co. of Japan, and Allen Everett, Ltd., of England. In addition, Bailey electric furnaces have been installed in the following three Canadian plants: the Dominion Steel Products Co. of Brantford, Ontario; the Monarch Metals Co. of Hamilton, Ontario, and the Union Screen Plate Co. of Lennoxville, Quebec.

Watson-Stillman Co., 192 Fulton St., New York City, manufacturer of hydraulic machinery, recently conferred expressions of appreciation upon a number of employes who have been with the company for many years: Walter Watson, who has been in the continuous employ of the company for fifty years, was presented with a check for $1000, and provision was made for paying him a pension upon his voluntary retirement. William Graudorf, T. W. Hammond, A. D. Carnes, J. Hardy, William Koshwitz, William Melly, and C. J. Wessels, who have all been in the continuous employ of the company for more than twenty-five years, were each presented with a gold watch suitably inscribed. Carl Wigtel, who has also been with the company for many years, was presented with a watch fob.

Landis Machine Co., Inc., Waynesboro, Pa., manufacturer of bolt and pipe threading machines, has recently completed an addition to its shop which will be used as the main machine shop of the company. The new building is 308 feet long and 146 feet wide, of fireproof construction. The walls and ceilings are constructed mainly of glass, which affords an abundance of light. In connection with the completion of the building, the company gave a housewarming party in the shop to its employes and their families, which was attended by nearly 1400 people. Speeches were made by J. G. Benedict, general manager, and S. F. Newman, assistant general manager. A vaudeville entertainment and a male chorus were features of the evening. After refreshments were served, an orchestra furnished music for dancing.